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This Special Engineering Issue

WEBSTER defines engineering as the "art and science by which the mechanical properties of matter are made useful to man in structures and machines". That is a fine definition except that in connection with the oil industry he might have added "and processes".

The oil industry began its operations in the dark—all branches of it.

Men found out how to drill wells, how to get oil out of them, how to refine it into the few simple products then marketable, simply by trying one way and then another, finding more or less crude methods of solving their problems as they arose; feeling their way.

Fifty years ago, the scientists had paid very little attention to petroleum. There was no literature to guide the producing man or the refiner in improving his processes and his methods.

As the industry grew and developed the study and experiments of the men in it gradually dispelled the darkness and brought the industry out into the daylight where the active operating men could see what they were doing. Within the past four or five years, however, the complications and difficulties of making fair profits have increased many fold.

Daylight was not enough. In response to the needs of the petroleum industry, a group of specialists has developed, each concentrating on some acute problem the solution of which spelled dollars and cents to the operating oil man. These specialists have been turning the spotlight on the various phases of the industry and they have made important discoveries.

They have made themselves masters of the knowledge of the physical and "mechanical properties of matter" as applied to their own particular fields. They have made these properties "useful to man"—particularly and immediately to the operating man in the oil business—to an amazing extent, an extent which is revolutionizing operating methods in all branches of the oil industry.

It is the purpose of this Special Engineering Issue to pass on to readers of NATIONAL PETROLEUM NEWS in as great a measure as possible, this advanced scientific and engineering knowledge. We believe that more practical engineering information useful to operating men in all branches of the oil business is contained in this issue than has ever been compiled before between two covers.

The men who have been most active in working out these developments and making them available to the oil industry to make possible better products at lower cost, to turn red figures on the ledger into black, are the men who were asked to write the articles in this Special Engineering Issue.

They have responded heartily. NATIONAL PETROLEUM NEWS thanks them one and all and we believe our readers will thank them too. They have rendered an important service to the industry.

Most of them need no introduction to operating oil men. Some are outstanding figures in the engineering world. All of them know their stuff.

With this brief introduction we ring up the curtain and invite you to read the contributions of these engineers, beginning on the next page.

Evaporation Loss, Factors Affecting and Practical Methods of Reducing It

By H. H. Fleming

NOW that most of us have an uncomfortably large part of our capital tied up in stored oil, the evaporation problem deserves careful consideration. With profits nearing the vanishing point the difference between red ink and black on the balance sheet may be found in the amount of gasoline going into thin air from our tankage.

Whether the tanks contain gasoline or crude, what evaporates is gasoline. With so much crude being bought on a gravity basis this fact is brought home rather forcibly when evaporation drops the crude into a lower price class.

Even the pipe line companies now realize that evaporation, which was formerly thought no worry of the carriers, is eating into their profits; especially if the producer keeps the crude in pressure-tight tanks and the pipe line releases that pressure in its own tanks with old roofs and open vents.

To entirely eliminate evaporation loss is out of the question and in trying to save the last fraction of a per cent it is possible to spend more money on an elaborate recovery system than the saving will justify. But there is no question that the greatest part of what is lost today can be saved and saved without excessive capital expenditure. To consider just how this can be accomplished with the greatest saving per dollar invested is the object of this discussion.

Evaporation is costing this country about one billion gallons of gasoline annually. This may seem incredible but several authorities place the figure somewhat higher and I believe a billion gallons is conservative.

Saving a large part of that billion gallons is not only conservation but profitable business. The greater part of the preventable loss is that from standing storage and we will therefore limit ourselves here principally to consideration of oil in storage.

Pumping Losses

PUMPING losses while well worth attention are much less than commonly supposed. Theoretical computations have been made showing the amount of air displaced each time a tank is filled and the amount of gasoline carried off in the vapors. But most of these figures overlook the fact that it takes a very appreciable time for the air in the tank to become saturated. When oil is pumped into a tank at usual rates and temperatures, only the last part of the air to leave carries any great amount of gasoline. One company found to its surprise that the pumping loss was less than they could measure even with special gauging equipment.

Two 12 by 40-foot tanks were used in these tests with enough U. S. Motor gasoline to fill one. The gasoline was pumped from one tank to the other and a very careful gauge taken before and after. An average of more than 20 tests showed a difference so small that it was well within the experimental error. In fact, a number of tests showed gains so that the conclusion of this company is that the loss was too small to be measurable even on full-size tests such as this. This applies only to tanks that are frequently worked. If a tank is filled or emptied only infrequently the actual pumping loss will be close to the theoretical but of course, if the pumping is infrequent the total loss is not important.

To give definite figures as to the amount of gasoline lost by evaporation is difficult because of the widely varying conditions. However, the following figures are the result of 10 years' observation and the compilation of data from various parts of the country and hold for average conditions.

GASOLINE in tanks with old style steel roofs of 1½-inch to 1 foot pitch with loose riveting and open vents will evaporate at the rate of 5 to 7 per cent annually, and even faster, if the roof is in bad condition or gauge hatches do not close tightly. The rate of evaporation from crude oil depends, of course, on volatility of the crude stored, but the following figures are fairly representative of the evaporation of Mid-Continent crude stored in large tanks after the lightest fractions have been lost in the lease storage.

Wood roof tanks 3 to 6 per cent.

Wood roofs with gas-tight insulated tank tops ¾ to 1½ per cent.

Old style steel roofs 2 to 2½ per cent.

Gas tight steel roofs with breather valves ½ to ¾ of 1 per cent.

H. H. FLEMING

Mr. Fleming is vice president and general manager of the Oil Conservation Engineering Co., Cleveland, O. Mechanical engineer, graduate University of Michigan. Former chief engineer Standard Oil Co. of New Jersey's properties in Rumania.

While employed by the Standard of New Jersey, Mr. Fleming was for some time assigned to the development department where he was a member of the committee charged with the study of evaporation loss and means for reducing it.

PROBABLY the most accurate data available on crude oil is that of one of the companies in the Mid-Continent field which had twenty-seven 55000-barrel tanks filled with a good grade of Oklahoma crude and undisturbed for a period of seven years. The average figure on this large amount of oil over this long period is not subject to the usual errors of short time evaporation tests on one or two tanks. These tanks had the usual type of wood roofs covered with sheet steel and tar paper commonly used until recently in the Mid-Continent field. In the seven years this crude was in storage it lost 17½ per cent in volume and 4.9 degrees in gravity. The loss the first year was close to 7 per cent and the last year about 1 per cent.

Another company topped a large quantity of Oklahoma crude before putting it in storage. A 64-gravity naphtha cut was taken off which amounted to about 10 per cent of the crude. At the same time several fifty-fives were filled with crude from the same pool untopped. After standing in storage a few years the gravity and distillation curves of the topped and untopped crudes were nearly identical.

How far we can go economically in reducing these losses is a separate problem for each owner of tankage, but it is not sound business to store gasoline with a loss of over 1 per cent per year and the loss from

the average crude oil should be a fraction of 1 per cent. For these results can be accomplished with comparatively little expense.

BEFORE discussing methods of prevention it might be well to list the factors which control evaporation. The three fundamentals are:

1—The area of oil surface exposed.

2—The amount of unsaturated air passing over that surface.

3—The degree to which the air becomes saturated with gasoline before leaving the tank.

The unsaturated air passing over the surface of the oil comes from two sources, windage and breathing. The factors on which these depend might be listed as follows:

A—From windage:

(a) Tightness of the roof and fittings.
(b) Number and location of vents.
(c) Breather valves on the vents.

B—From breathing:

(a) Volume of vapor space.
(b) Degree and frequency of temperature variations in vapor space.
(c) Pressure at which valves are set.
(d) Degree of saturation of air inhaled, (where it comes in whole or in part from some type of gas holder).

The degree to which the air becomes saturated depends upon the following three factors:

A—Vapor pressure of the oil.

B—Temperature of oil at the surface.

C—Time which air is left in tank (important only in tank which is frequently worked).

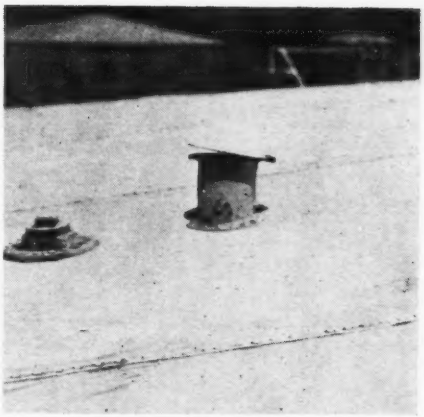
From a study of the above fundamental causes of evaporation and of the factors affecting these causes, we find there are some 8 conditions which we would like to obtain if practical. They might be listed as follows:

1—Minimum surface of oil exposed.
2—Gas tight roof and roof fittings.
3—Breather valve on vent.
4—Minimum vapor space.
5—Minimum temperature variations in vapor space.
6—Roof capable of holding maximum pressure.
7—Return of exhaled gases to tank.
8—Minimum temperature of oil at surface.

With these optimum conditions in mind we can consider the various types of tankage now being used for holding volatile liquids.

Floating Roofs

BY KEEPING the surface of the oil entirely covered we can of course prevent evaporation. Many attempts have been made to build a tank with a minimum of exposed oil surface. A floating roof will accomplish this but on the other hand offers mechanical difficulties that are rather troublesome. The seal at the edge of the float must slide over protruding rivets and still remain gas-tight and spark-proof with no danger of catching sufficiently to tip and sink the roof.



This is one thing that leads to excessive evaporation loss. Note how the hinged cover on the hatch is sprung, making it impossible to close tightly.

The mechanical difficulties of a drain that will properly function at all times are so great that some companies have built the regular roof on their tanks in addition to floating deck in order to prevent the sinking of that deck. This also eliminates the cleaning of ice and snow from the floating deck which is an undesirable feature of the uncovered floating roof in northern climates. This additional roof over the floating deck also eliminates a feature of the floating roof which may have been overlooked. Eliminating a surface prevents evaporation but does not prevent boiling if the floating deck becomes hot enough. The writer was recently told by a refinery engineer that he had found temperatures on the floating decks 20 to 30 degrees higher than the initial boiling point of the gasoline stored. It has been proposed to support the floating deck above the surface of the oil on pontoons to prevent the heat being carried to the oil through the steel plate of the deck, but of course this defeats the original purpose of the floating deck.

Where floating roofs are used care should be taken to equip the annular vapor space around the rim with dependable pressure relief valves as when pumping into a tank the air and gas in the incoming oil tend to make a gas lift around the seal unless properly protected. It is possible for such a gas lift to carry enough liquid onto the roof to sink it.

Floating decks will materially reduce evaporation losses when installed under favorable conditions, especially if a roof is built over them, although they make rather expensive installations.

Foam Blanket

ATTEMPTS have also been made to make a floating seal of foam to cover the oil surface and this worked satisfactorily where the seal was not destroyed by the oil or moisture. Difficulty has been experienced in making a foam stable enough to stand up under these conditions and also in preventing it from getting into lines, pumps, etc.

Vaporless Tank

ANOTHER tank which eliminates exposed surface is the Fleming vaporless storage tank so constructed that there is no vapor space and the surface of the oil is protected by a simple inverted water seal which prevents all access of air but allows expansion and contraction of the oil without any moving parts. The disadvantage of this is that it is no better than an ordinary water-top tank when it is partly empty. The full advantages are available only when the tank is filled to capacity. However, most storage is kept filled and for such service this tank seems to offer the possibility of zero evaporation loss and a minimum fire hazard. The cost is about 15 per cent more than that of a tank with ordinary cone roof.

Gas-Tight Tanks

THE second and third conditions in the above list undoubtedly offer the most effective and most available means of reducing evaporation in the present type of tankage. One large oil company after two years' survey found that its evaporation loss in steel-roofed tanks was made up of two thirds windage loss and one third breathing loss. Others have found windage responsible for even a larger percentage of the total losses when riveting is loose and fittings antiquated. It takes a very small opening at the eaves or roof seams to cause a current of air to blow through the tank, especially if there are open vents.

The first step in cutting down evaporation is to plug the leaks in the roof and see that all fittings are gas-tight. If tanks still have old style windlass boxes on the roof, instead of safety winches mounted on the shell, these old boxes can at least be made tight by putting on new gaskets, bolts and nuts.

Gauge hatches are another large source of loss. Where a screw cap is used on a nipple, threads are often found to be corroded away so that it is impossible to replace cover, but in many cases open gauge hatches are simply due to gauger's carelessness. The modern type of gauge hatch eliminates this by making it much more difficult for the gaugers to leave them open than closed.

Vents and Breather Valves

It has been common practice in some sections to put several vents on a tank, offering an opportunity for wind to blow into one and out through another, thus passing fresh air over the surface of the oil and greatly accelerating evaporation. Only one

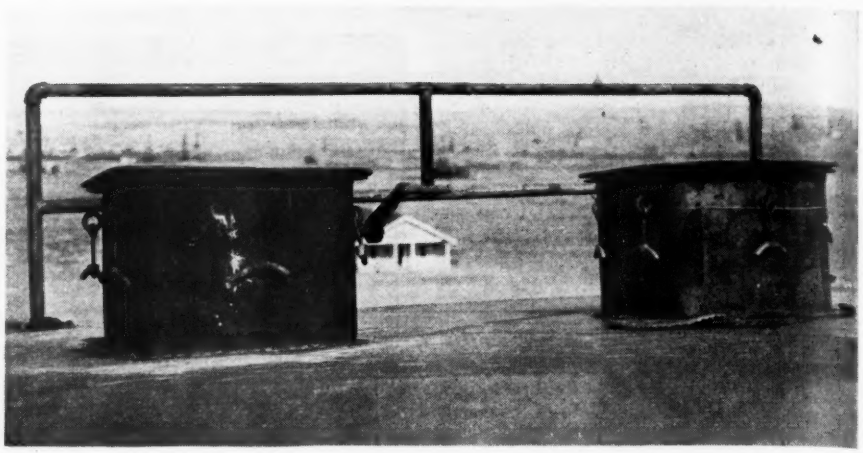
vent should be used on a tank, especially where vents are not valved.

A carefully conducted test of two identical tanks except that one had two open vents and the other had only one, showed a loss in the former of 7.7 per cent against 1.4 per cent in the single-vented tank. Another type of vent which is particularly bad is made from a T supposedly screened at both ends. As the wind blows through this T we get an aspirator effect. A large source of loss has been the long vent line carried down from the tank roof and outside of the fire wall. These long lines act as air cooled condensers with the tank as the still. Furthermore, condensation collects in the lines and is very difficult to drain out safely.

This has resulted in a number of wrecked tank roofs. The long vent lines originally used on the now exploded theory that they were safer from fire than venting on the roof were very wasteful as well as unnecessarily costly. As a matter of fact, vapors discharged at the top of the tank are rapidly dissipated whereas those discharged close to the ground roll along as a highly explosive mixture and collect in low places readily accessible to cigarettes and other fire causes.

THE theory that a rising column of vapors attracts lightning has been shown groundless by laboratory experiments with lightning, although this was hardly necessary when it is remembered that oil vapors are heavier than air and do not rise in a column from the tank. Every tank containing volatile liquid should have its vent protected by a vacuum and pressure relief valve set at whatever working pressure is safe for the weight of the roof used.

In many cases this pressure is low and it does not take very much temperature change to open the valve but even in such cases the valve helps greatly to keep down windage as well as the minor breathing cycles due to small temperature changes caused by clouds passing over the sun and changes in the wind. These seem to be considerable as many tests have shown the actual savings due to breather valves were considerably higher than theoretical figures. One long period test on 80,000-barrel tanks filled with gasoline showed an average loss from 7 tanks of 2 per cent, while 3 identical tanks equipped with breather valves lost less than ¼ of 1 per cent a year. Another engineer who has made a specialty of evaporation losses reports an average loss of ¾ of 1 per cent per year with valves on gasoline tanks where similar tanks lost 1½ to 3 per cent without valves. Valves are comparatively inexpensive and the best of them should pay for themselves in a very short time. Failure of a vent valve is a serious matter and care should be taken in selecting such equipment.



Sprung covers on windlass boxes on tank roof. Gasket supposed to keep cover tight can be seen at the right lying on the roof in front of the box.

Minimum Vapor Space

WITH other conditions fixed, the amount of breathing is almost directly proportional to the vapor space in the tank. For this reason modern tanks are being built with a much lower roof pitch than formerly. On a well built tank a slope of ½-inch to 1 foot is sufficient to adequately drain the roof and there is no good reason for building tanks of any higher pitch.

Tanks should also be filled as high as possible leaving only enough outage to take care of the expansion, in most cases 6 inches being sufficient. This is assuming, of course, that there are no openings in the top ring. Some tanks have been built with the sheave bracket which carries the swing pipe cable so constructed that the cable is brought through the top ring instead of the roof.

Putting such a hole through the top ring cuts the effective height of the tank by the distance from the bottom of such hole to the roof and is a wasteful type of construction. Of course, there are many wooden roof tanks which allow so much rain to get through that the level of the oil is raised several inches in a season and the water must be siphoned out at regular periods. Under such conditions it is not safe to fill the tanks too full, but fortunately wooden roof tanks are pretty much a thing of the past now and where the tanks will permit it a surprisingly large amount of evaporation will be eliminated by carrying only the outage that is actually necessary.

Temperature Control

AFTER tanks have been made tight the amount of breathing can be reduced still further by reducing the temperature variations in the vapor space and by keeping the surface of the oil as cool as possible.

For the amount of air breathed in and out is a direct function of the temperature changes when those changes are sufficient to open the breather valves, and the saturation of the vapors breathed are a function of the vapor pressure of the oil at the surface which in turn depends upon the temperature at that point.

Water top tanks have been used for this purpose but the mechanical difficulties and expenses both in first cost and operation have not been popular. Many people also object to the water top tanks on the ground that in case of an explosion the shell gives away instead of the roof with serious consequences. Water top tanks will, however, show a low evaporation loss when kept well filled and the vents protected by breather valves, for not only are such tanks cooler but they have comparatively small vapor space.

Water sprayed over the roof will also reduce the temperature but few plants have water available for such purposes and where they do it is usually sea water which eats out the roofs very rapidly, and a leaky roof is much worse than a hot one.

Much work has been done on the comparative cooling effects of different colored paints and as a result very few tanks are now covered with the black, dark red or rust that were once so prevalent. A light colored, heat reflecting paint costs little more and is a sound investment. In fact, if the under side of the tank roof could be painted at a reasonable cost it would also help to reduce evaporation as less heat would be absorbed by the oil and vapors from the roof.

Insulated Tanks

ANOTHER means of temperature control is insulation. Early efforts in this direction consisted in insulating the entire tank but this was soon abandoned for the insulated roof only. The insulated roof cuts down the peaks of the vapor temperature curve and thus reduces the evaporation loss not only by keeping the vapor space cooler in the daytime but also maintaining its temperature at night. The insulated roof besides greatly re-

ducing the breathing, eliminates windage. In fact, on non gas-tight roofs an insulated tank top is of more value in stopping windage than breathing, especially where the eaves are properly sealed. It also helps to solve the problem of obtaining a gas-tight roof in fields such as the Panhandle where it may be impractical to build steel roofs on account of their rapid deterioration.

With a gas-tight tank having minimum vapor space, breather valves and insulated roof, evaporation losses can be reduced to an exceedingly low figure. The insulated roof can be built at a reasonable expenditure considering the savings effected and should last many years if skillfully applied.

A number of tanks have been protected against the sun's rays by hoods completely surrounding the tank and separated from it by an air space. However, results shown in the data which the writer has seen on a number of such tanks hardly justify the expense.

Pressure Tanks

IF we could build a gas-tight tank which would hold all the pressure generated by expansion and contraction of the oil and gas, we could entirely eliminate evaporation. Tanks have been built which hold sufficient pressure so that the breather valves which are set for these high pressures open only under the most extreme conditions. The spherical tanks used for storage of casinghead gasoline are a good example of this and are one of the most effective means of eliminating evaporation. However, they are naturally high-priced containers and are limited to comparatively small sizes, most of them being not over 10,000 barrels. However, it has been shown entirely feasible to build even the largest tanks in a manner to hold motor gasoline without breather valves opening more than a few days in a year. The evaporation committee of the Standard Oil Co. (N. J.) have done some very excellent work along this line which was discussed by Mr. John A. Britton, Jr., in the July 21, 1926, issue of NATIONAL PETROLEUM NEWS, page 24. They found that with vent valves set for 13 inches of water pressure, breathing was practically eliminated and they developed an 80,000-barrel dome roof tank that would stand such pressure and yet could be built for very little more than the standard cone roof.

Another large company has built similar tanks working at a pressure of 1¼ pounds to the square inch. There are more than a million barrels of gasoline now stored in this type of tankage with excellent results.

Gasometer and Breather Bags

Another method of eliminating evaporation loss from breathing is to provide for the return of exhaled gases to the tank. A number of installations have been made where tanks were allowed to breathe in and out of a gas holder and if there are no leaks in the system there is of course no evaporation loss. However, this has not proven a very economical system for the reason that it is very difficult to prevent leakage of gas and the first cost is extremely high. Since most tanks have a safe working pressure of about 1 ounce per square inch there is very little pressure available to send the gas through long lines to a gas holder and therefore large diameter lines must be used. Such a piping system with a gas holder of sufficient size makes a very costly installation. The condensation in these lines also presents a serious problem. A modification of this system has been developed using fabric gas bags for gasometers. These bags are located close to the tanks and serve from one to four tanks each. This reduces cost of piping and is much cheaper than a steel gas holder.

It is customary to so proportion the bags that they will take care of only a part of the breathing as a bag, to take the full breath under extreme conditions, would need to be of excessive size. What cannot be taken care of by the bag escapes to the air through breather valves. While such an arrangement is less expensive than the usual type of gas holder, the life of the bags is still problematical. They are coated with a special gasoline-proof dope which seems to be standing up very well.

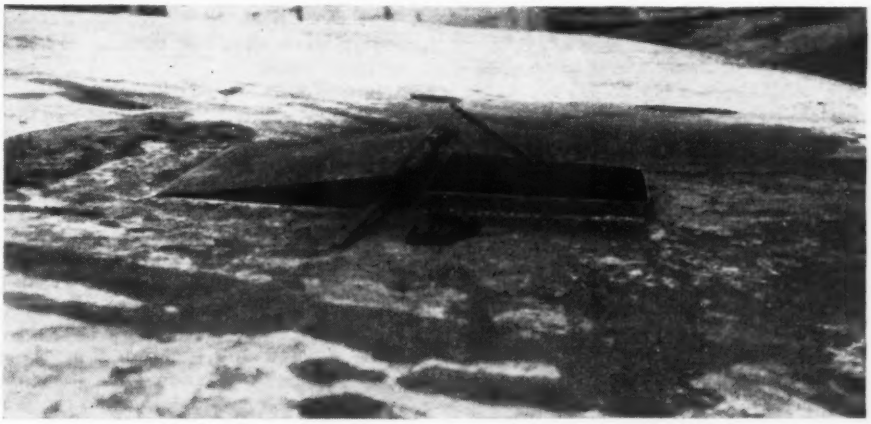
With any gasometer system using either the steel gas holder or breather bag, the expected return in evaporation saving must be computed for each individual case to determine the amount we are justified in spending on the installation. All of these systems require a gas-tight tank equipped with breather valves and the savings effected must be compared with losses from such a tank when not connected to a gas holder.

Wherever tanks are connected with each other through their gas lines, each tank should be protected from the rest of the system by a flame arrester and it should be remembered that a screen is not an effective flame arrester in lines over 4 inches in diameter. A large part of the time the gases in such a system are too rich to carry an explosion but there are many times when there is sufficient air in the mixture to endanger all the tanks which are interconnected. The best method is to install the flame arrester adjacent to the tank and above it a T. The upper end of the T is to carry the vacuum and pressure relief valve and the side outlet is connected to the gas system.

Recovery Systems

ALL the above deals with preventing evaporation. But it is also possible to allow the stored oil to evaporate and later recover the gasoline from the vapors. Such recovered gasoline is then stored and again evaporated and recovered at an appreciable cost for each time it makes the circuit. Under certain conditions it may pay to do this; for instance at a refinery equipped with a gas recovery system which can carry the additional load at not too great a cost, it will undoubtedly pay to take the vapors from the receiving pans and the working tanks if not too distant from the recovery plant. On the other hand, there are very few storage tanks which it will pay to handle in this manner, especially where it is necessary to build additional recovery plant capacity for this purpose. Long and expensive lines are required, the gas delivered to the system may be very lean and the supply very irregular. A plant which would take care of maximum requirements would have a very low load factor indeed. When all capital charges and operating costs are properly apportioned to such a system I very much doubt if a profit can be shown that would warrant such an investment.

The remarks in an earlier paragraph pertaining to the fire hazard of interconnected tanks also apply to recovery systems.



This picture speaks for itself. It was easier for the gauger to leave the cover open than to close it. Profits escape through the manhole.

Fire Hazard

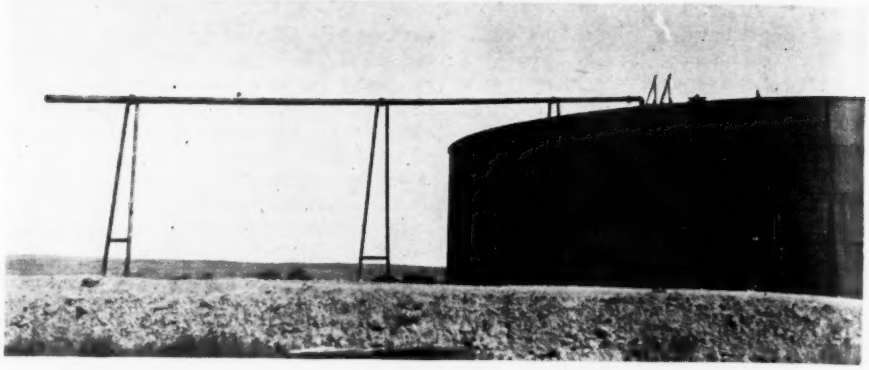
THE protection of tankage against fire is so closely interwoven with protection against evaporation that a word here on that subject may not be out of place. The best protection any tank can have against fire, including lightning, is a really gas tight roof with the necessary breather vent the only opening and that opening protected by a flame arrester. (Screening, even 40-mesh, doubled, is not an effective flame stop in pipe over 4 inches in diameter.)

Such a tank cannot burn until broken open. If the roof is of steel the tank also has the best known protection against lightning. A careful search of fire records has failed to disclose the loss of a single steel tank by fire of any kind where the tank openings were protected by fittings bearing the approval of the Underwriters' laboratories.

So that if a tank is properly protected against evaporation it has also the best protection known against fire.

Summary

Briefly summed up, then, the first steps in reducing evaporation loss consists in reducing vapor space to a minimum by low-pitched roofs and keeping the tank well filled up. Secondly, by making the roof and roof fittings gas tight; third by equipping the vents with an effective breather valve. These three fundamentals may then be supplemented by insulation, high pressure roofs, gas holders, tanks of special shape and so forth. How far we can go in this direction depends entirely upon the local conditions obtaining in each case. The savings to be accomplished by any given type of installation will determine the expenditure which we are justified in making.



A 55-barrel all-steel gas-tight tank vented to the air through a 6-inch line unprotected by screens, a fire hazard.

In other words, conservation must be self-supporting. However, there are few places in the oil industry where a small expenditure will show greater returns if intelligently applied.

Things to Avoid in Installing Bulk Station Pumps

By F. J. Curtis

President, Pittsburgh Machine Tool Co.

ONE of the greatest sources of trouble in the installation of gasoline pumps at bulk stations is the tendency of the user to install smaller suction lines than are specified by the manufacturers, forgetting that the area of the pipe increases or diminishes as to square of the diameter. The suction line that is too small builds up a high vacuum, which has a tendency to separate the gas from the liquid, or in other words, gasify the gasoline. The consequence is that the pump then handles a large percentage of gas in place of gasoline, and it follows that the gas passes off at the end of the discharge line and is lost. This loss can run into a considerable item in a year's time.

Then again there are users who insist on long suction lines. This practically has the same effect as reducing the diameter. Another trouble that often occurs is to leave the suction line exposed to the sunlight in the summer time. When this line becomes heated by the sun, the capacity of the pump is greatly reduced and a large amount of wastage occurs through handling gas in place of gasoline. It is always well either to bury the suction line or box it in. If boxed in, in should be surrounded by some sort of insulating material. In any case the wisest thing to do is to place the pump as near the source of supply as possible.

Another source of trouble often occurs through the lack of a screen on the suction line, to keep foreign matter out of the pipe. This screen, if installed, however, should be of ample size, and for safety's sake, three or four times the area of the pipe, and should be examined from time to time, as all kinds of foreign matter is liable to stick in the screen and eventually shut it off, either wholly or partially.

By-pass valves are often installed on the discharge side of the pump. These are another source of trouble. Some by-pass valves are so designed that they bring an abnormal strain on the pipe lines through the water hammers when they are closed. When a by-pass valve is installed, a large air chamber should also be installed, which will cushion the shock to a certain extent.

A great deal of care should be exercised in installing a pump to see that it is absolutely and well grouted in, on the foundation, as it is possible to spring the pump base or frame with the foundation bolts, if a great deal of care is not used. The springing of this frame will throw an abnormal amount of friction on the bearings, packing glands, etc., which will soon cause trouble, besides consuming more power than necessary.

Another thing that has a great deal of importance in pump installation, is the proper aligning of pipes. If a length of pipe is screwed into a pump by a careless workman, and is an inch or two out of line and is then sprung into place in making connections, it is almost a certainty that the pump base will be sprung, throwing everything out of line. A great many people do not recognize the fact that a casting will spring, therefore the lines should be lined up absolutely true before they are connected.

In gasoline pumps, especially the rotary type, the question of lubrication is quite a serious problem, as there is very little lubricating quality in gasoline.

Therefore, in purchasing a pump for handling gasoline, it is advisable to have either oil-less bronze bearings, or better still, ball or roller bearings. With the roller bearings, if they are located where the gasoline does not reach them, these bearings can be packed with grease once in three months which will give all the lubrication necessary. It is well also to remember that if pumps are allowed to stand any length of time—say over the winter months, it is a good idea to start them occasionally and run them. The writer believes that if the above suggestion would be followed, a great deal of pump trouble would be avoided.

Efficient Fire Protection System For an Average Refinery

By Harold L. Kauffman

DURING the past 12 years engineering efforts towards finding a practical way of extinguishing oil fires have resulted in the extensive use by oil companies of the "frothy mixture" system. Tanks, pumps, pipelines, mixing chambers and means for distributing the foam represent the essential equipment required in such a system.

As is generally known among refiners, the principle feature involved in this method of extinguishing oil fires is the formation of a thick, tenacious foam, consisting of bubbles filled with a non-inflammable gas. This is produced by bringing together two chemical compound solutions, each solution containing two or more chemical constituents.

When the foam thus formed spreads over the burning oil, the flames are extinguished. The chemical constituents of the compounds used must be fairly cheap and must not deposit any great amount of sediment. The proportion of froth to the solution should be about 6 or 8 to 1; in other words, mixing together 50 cc. of each solution should produce from 600 to 800 cc. of foam.

The Foamite-Childs Corp. of Utica, N. Y., recommends that foamite solutions be made up as follows:

Solution "A":

For each gallon of solution "A", use:

1.16 lbs. of aluminum sulphate.

0.935 gallons of clear, fresh water.

Solution "B":

For each gallon of solution "B", use:

0.265 lbs. of firefoam liquid.

0.708 lbs. of sodium bicarbonate.

0.945 gallons of clear, fresh water.

Because refinery executives may wish to give consideration to the essential foamite equipment, and method of operating same, required for adequately protecting their refineries against fires, the present article will be limited to a detailed description of the fire-protection system installed at the 10,000-barrel refinery of Producers & Refiners Corp. at Parco, Wyo.

The foamite system installed at this refinery protects both the refinery proper and the refinery tank farm and consists of two steel solution tanks, nominal capacity 90,000 gallons each; a 15 x 8 x 18-inch National Transit twin duplex steam pump; and 6, 4 and 3-inch twin field lines with laterals 3 inches to 1½ inches connecting mains to mixing chambers.

The storage and run-down tanks at this refinery all are equipped with foamite mixing chambers. In addition, foamite hydrants are located at frequent intervals throughout the system for general protection around the refinery and for auxiliary protection of tanks.

HAROLD L. KAUFFMAN

Mr. Kauffman is a graduate in chemistry from Pennsylvania State College. Employed by The Texas Co. 1919-1922 as research and grease chemist and development engineer. Employed 1922-1923 by Pierce Petroleum Corp. as assistant chief chemist. Employed by Producers & Refiners Corp., 1923-1926 progressively as special process investigator, research chemist and development engineer, chief chemist Parco refinery and chief chemist and lubricating oil superintendent. Started in business for himself as petroleum consultant in Denver March 1, 1926. Has made inventions in connection with treating lubricating oil covered by two patents issued and one soon to be issued.

Solution Tanks

AS EACH chemical solution used in the frothy mixture system of fire protection requires one tank, two are at least necessary. The capacity of these tanks depends on the number of square feet of oil surface to be covered.

At the Parco refinery the two solution tanks, A and B are of steel, 25 feet in diameter by 25 feet high, nominal capacity, 90,000 gallons each. The A tank is lined with 8-pound sheet lead; the B tank is plain steel.

The B tank is equipped with an inside and outside steel ladder. There are no ladders on the A tank.

Each tank is provided with a manhole in the lower ring and one in the roof. The roof manholes are equipped with hinged covers. Access to both manholes is obtained by the ladder on the B tank.

The tanks are equipped with float gauges which register correctly.

A hollow tile structure is built around the tanks for protection in cold weather.

The tanks are painted black.

A pipe hand-rail is installed at the roof manholes.

Solutions

SOLUTION A when properly made up, shows a specific gravity of 1.073 at 75° F.; solution B 1.061 at 75° F.

It is advisable always to keep on hand an extra half charge of foamite chemicals as a precautionary measure.

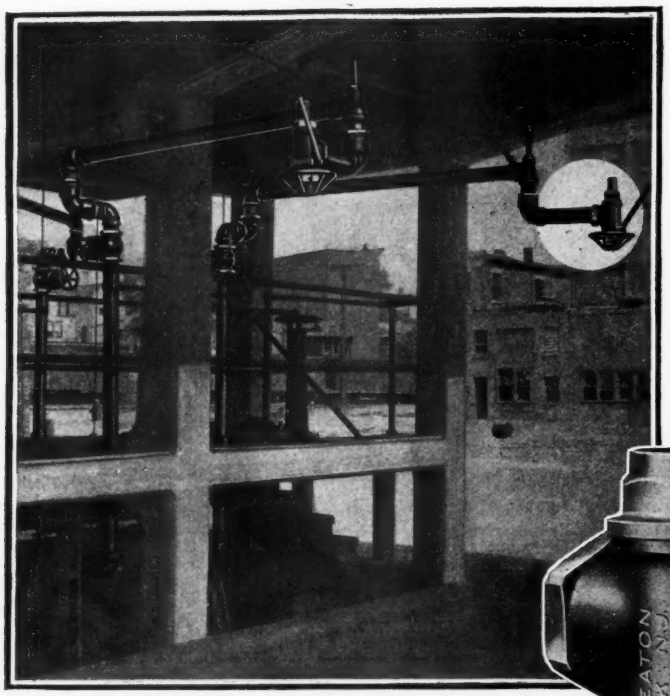
Dissolving Tank

THE dissolving tank in use at this refinery is of reinforced concrete, 10 feet 6 inches long by 8 feet wide by 4 feet 6 inches deep. It is provided with necessary steam, air, water and drain connections.

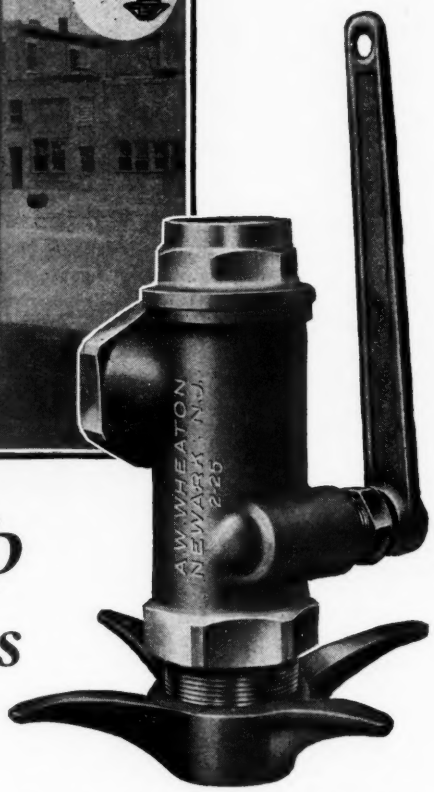
The valves at the dissolving tank are boxed in for protection; while the tank itself is provided with a wood cover for protection from the weather.

Air Agitation

AIR protection for dissolving chemicals and agitating the solutions at intervals is supplied by the refinery air compressor. The B tank is equipped with a grid of 1-inch and half-inch perforated steel pipe resting on the floor of the tank; the A tank is equipped with a coil of 1-inch lead pipe, perforated. This piping connects with the refinery air supply. Valves controlling the air to each solution tank are located in the foamite pump house. The dissolving tank is equipped with a grid of 1-inch and half-inch perforated steel pipe for air agitation when dissolving chemicals. The air supply available is adequate for dissolv-



The photograph at the left shows an installation of Wheaton Type 25 Loading Valves—also, Wheaton Double Swing Joints.



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Send for a sample of Type 25 Loading Valve—if it does not prove entirely satisfactory you may return it for full credit or refund. Also, ask for the illustrated Wheaton Catalog, which fully describes all Wheaton Products.

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ing the chemicals and agitating the solutions in the tanks.

Foamite Pump House

THE foamite pump house is of brick, 29 feet long by 16 feet 2 inches wide. It is equipped with seven windows and one double door. The house is well lighted. A layout of the foamite system field piping is posted in the pump house. Operating and maintenance instructions, furnished by the Foamite-Childs Corp. are framed and posted in the pump house. The door of the foamite pump house is kept locked and a key placed in a box with a glass cover at the door. Keys are also given to those responsible for the operation of the system. A complete set of pump tools is kept on a rack in the pump house.

Pump House Piping

THE pump house piping was tested at 180 pounds per square inch hydrostatic pressure before the equipment was reported ready for use, and it was considered satisfactory only when no leaks resulted after each test. All suction and discharge piping is well supported from the trench floor. An air connection made on the field line header in the pump house is used for draining field lines. The pipe trenches are covered with steel plate. The steam lines to the foamite pump are well insulated. A trap takes care of condensation in the lines. Two steam coils for heating are installed in the pump house. Enamel signs are in place to indicate the pump manifold valves. Suitable signs also are posted over the field control valves. All pumps and piping are suitably painted.

Foamite Pump

THE foamite pump is a 15 x 8 x 18 inch National Transit twin duplex steam pump, 3-inch steam inlet, 4-inch exhaust, rated at 520 G.P.M. each solution, at a piston speed of 100 feet per minute, or 33 revolutions per minute. As shown by the tests made with the steam pressure available, the pump can be easily speeded up to 38 revolutions per minute, equivalent to a discharge of 590 G.P.M. of each solution. The pump is well set on heavy concrete piers. The pump was tested at 180 pounds per square inch, with no leaks resulting, before being considered ready for use.

The following tables give data on pump tests made:

The relief valves start operating at 155 pounds per square inch. After the charging of the solution tanks the above results were repeated with practically the same results. Grooves are present in the pump foundations at the solution ends so as to drain off any water or solutions that might collect inside the pump base.

Pumping Tests

THE following tests were run on the foamite pump before it was considered to be satisfactory for meeting operating conditions:

Test No. 1

Pumping to Tank No. 510. (55,000 bbls.)

Steam pressure .....130 lbs.
Fluid pressure .....65 lbs.
Pump Speed .....38 R. P. M. (18" stroke)
Pumping for .....10 minutes
Quantity pumped out of "A" tank—18" 5508 gals. 551 G. P. M.
Quantity pumped out of "B" tank—18" 550⁹ gals. 551 G. P. M.

The unions on the risers to the mixing chambers were broken and water then pumped from the solution tanks through the lines. This gave conditions approximating those existing during actual operation of the system.

520 G.P.M. of each solution is the pump discharge required for a tank of this size. With the steam pressure available during the test, a discharge of 551 G.P.M. was easily obtained. This was 31 G.P.M. above requirements. The test showed equal quantities pumped from each tank.

Test No. 2

Pumping to tank 301. (10,000 bbls.)

Steam pressure .....128 lbs.
Fluid .....65 lbs.
Pump Speed .....23½ R. P. M. (18" stroke)
Pumping for .....10 minutes
Quantity pumped out of "A" tank—11 3/16" 3423 gals. 342 G. P. M.
Quantity pumped out of "B" tank—11 3/16' 3462 gals. 346 G. P. M.

251 G.P.M. of each solution is the pump discharge required for a tank of this size. With the steam pressure available during the test, a discharge of 344 G.P.M. was easily obtained. This was 93 G. P. M. above requirements. The test shows that the A pump discharged 1.1 less than the B. This difference is negligible.

Test No. 3

Using two hose streams

300 ft. (working length) 1½-inch hose was connected to each of two hydrants.
Steam pressure .....125 lbs.
Fluid .....150 lbs.
(Relief valves operating).
Pump speed .....26 R. P. M. (18" stroke)
Pumping for .....10 minutes
Quantity pumped out of "A" tank—7½" 2295 gals. 230 G. P. M.
Quantity pumped out of "B" tank—7⅝" 2333 gals. 233 G. P. M.

The results of this test show a discharge of 115 G.P.M. of each solution from each hydrant. The relief valves were operating during this test and part of the discharge was passing back into the pump suction. The "A" pump discharged 1.2 per cent less than the "B." This difference is negligible.

Test No. 4

Same conditions as for Test No. 3

Steam pressure .....125 lbs.
Fluid pressure .....150 lbs
(Relief valves operating).
Pump speed .....26 R. P. M. (18" stroke)
Pumping for .....15 minutes
Quantity pumped out of "A" tank—11" 3366 gals. 224 G. P. M.
Quantity pumped out of "B" tank—11¼" 3443 gals. 230 G. P. M.

The results of this test show an average discharge of 113 G.P.M. of each solution from each hydrant. The relief valves were also operating during the test and part of the discharge was passing back into the pump suction. the "A" pump discharged 2.6 per cent less than the "B." This difference is within allowable limits.

Field Conditions

The main foamite pipe lines to the tank farm at the Parco refinery are 6 inches in diameter. Seven foamite hydrants at the refinery loading rack are connected to 3-inch supply lines.

Two foam headers are installed in the trenches of the receiving house of the refinery pressure cracking stills, one each at each end of the receiving house. These headers are made up of 8-inch tees with short lengths of 8-inch pipe open at the ends. The solution lines from the 3-inch main solution lines to the headers are 1½ inches in diameter.

The field piping in the refinery proper is from two to four feet underground. However, in the refinery tank farm most of the piping has been laid on the ground.

Drain valves were installed at low points in the system, even though the pipe lines were laid to grade so that care could be taken of drainage. Besides natural drainage, the lines may be blown out with air through an air connection in the foamite pump house. In most cases, the laterals are drained toward the tank and then have drain plugs at the bases of the risers to the mixing chambers. These plugs are boxed in.

Before being approved for use all foamite main lines and laterals were thoroughly flushed out and tested at 175 pounds hydrostatic pressure up to the unions on the risers to the mixing chambers. Foamite control valves all over the refinery and refinery tank farm are boxed in and control valve signs erected at each valve.

In the refinery proper where the main foamite lines are deep in the ground and the control valves to the mixing chambers are too far below the surface to be easily accessible, extended stems were installed on these valves so as to bring them within easy reach.

All field lines are carefully blocked

Slippage Test

End	Steam Press.	Fluid Press.	Slip in inches per minute	Slip	Maximum allowable slip
"A"	100 lbs.	135 lbs.	3"	0.3%	5%
"B"	100 lbs.	135 lbs.	5"	0.4%	5%

The slip in the pump is practically negligible.

Pressure Capacity Test

Steam Pressure	Fluid Pressure	Stroke	R. P. M.
100 lbs.	135 lbs.	18"	37
120 lbs.	140 lbs.	18"	38

Relief Valve Capacity Test

End	Relief Valve Setting	Relief Valve Capacity	Stroke
"A"	160 lbs.	38 R. P. M.	18"
"B"	160 lbs.	38 R. P. M.	18"

up to grade with permanent supports; and all lines inside the firewalls are covered with at least 6 inches of dirt.

The fire protection system at the Parco refinery is provided with 3000 feet of 1½ inch rubber-covered, rubber-lined hose. This hose is on five hose reels. One reel of hose is kept in the foamite pump house. The other four reels are kept either in hose reel houses, provided for that purpose, or are placed at strategic points in the plant. All the hose and the 10 combination nozzle sets were tested at 125 pounds hydrostatic pressure before they were considered satisfactory for use.

The amount of chemicals required for making 75,000 gallons each of solutions A and B is shown below:

88,400 lbs. or 221 bbls. of 400 lbs. each of acid aluminum sulphate.

53,200 lbs. or 133 bbls. of 400 lbs. each of sodium bicarbonate.

20,000 lbs. or 40 drums of 500 lbs. each of foamite solution.

The Parco refinery of Producers & Refiners Corp. was constructed, for the most part, by J. G. White Engineering Corp., 43 Exchange Place, New York City. The equipment for the fire protection system as installed at this refinery was purchased from the Foamite-Childs Corp. of Utica, New York.

The operating, maintenance and charging instructions for the foamite system as in effect at the Parco refinery is of interest to those who are not already familiar with the manner in which such systems are operated and maintained. These instructions are given to the user of their fire protection system by the Foamite-Childs Corporation:

1. Begin agitating the foamite solutions by means of compressed air.

2. Open wide main suction valves on pump. (Make sure suction valves at solution tanks and main discharge valves on pump are open. All other valves should be closed).

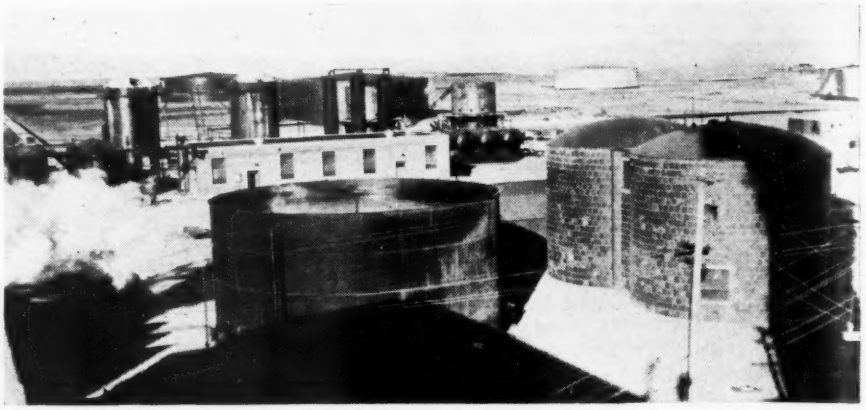
3. Open block valves in pump house to permit flow of solutions to location of fire.

4. Start pump slowly and bring up to a speed of 36.5 R.P.M. or until the relief valves operate. (The air agitation mentioned under operation No. 1 should not be continued longer than three minutes).

5. Open proper block and control valves to permit flow of foamite solutions to tank on fire. When opening foamite system valves, be careful to open wide the valves in both solution lines simultaneously.

6. Connect hose lines to foamite hydrant nearest available to fire, and use hose stream when and where warranted—for wooden timbers burning in the tank, and for oil burning on the ground around the tank. If nozzle pressure is low, allow mixing chambers to accomplish as much fire extinction as possible, then shut off flow to mixing chambers and use hose stream.

7. Extinguish a fire in one unit risk at a time. The pump has sufficient capacity to extinguish a fire in the largest unit risk. (A unit risk is a tank or group of tanks with its control valves so located as to be accessible in case of fire).



The two Foamite solution tanks at the Parco refinery of the Producers & Refiners Corp., insulated with tile, at right.

After a Fire

1. Immediately after a fire, salvage as much of the solutions remaining in the pipe lines as possible, returning them to their respective solution storage tanks. (See operation No. 2, under "pipe connections in pump house").

2. Wash out the pump and pipe line thoroughly with fresh water immediately after salvaging solutions. Exercise particular care to see that all lines which contained solution are washed out thoroughly.

3. Wash out all hose used, and replace hose on reel.

4. After washing out all pipe lines, drain them by removing drain plugs at low points and at all dead ends. Drain all parts of the pump thoroughly. Replace all drain plugs immediately after draining the lines.

5. Recharge solution tanks to their full capacity as soon after the fire as practicable.

Pipe Connections in Pump House

THE pipe connections between the foamite pump, solution tanks, dissolving tank, and air, steam and water supplies are so arranged that any of the following operations can be accomplished by proper manipulation of valves:

Operation No. 1:—Connect pump suctions to their respective solution tanks, and connect pump discharge to the main outgoing supply lines, which lead to the oil tanks and the foamite hydrants. Use this connection in case of fire.

Operation No. 2:—Connect pump suctions to main discharge lines and connect pump discharges to the suction lines extending to the solution tanks. Use this connection when reclaiming solutions from the pipe lines.

Operation No. 3:—Connect the pump suctions to the dissolving tank, and the pump discharges to the solution tanks. Use this connection when recharging the solution tanks.

Caution:—Be careful not to pump solution B into solution A storage tanks or vice versa, when pumping solution from the dissolving tank into one of the solution storage tanks.

Operation No. 5:—Connect clear, fresh water supply to the dissolving tank. Use this connection when filling the dissolving tank with water.

Operation No. 6:—Connect steam supply with dissolving tank. Use this connection for heating the water in the tank, when dissolving chemicals.

Operation No. 7:—Connect the air supply to the solution storage tanks and the dissolving tank. Use this connection when agitating solutions or dissolving chemicals.

Maintenance

1. Operate the pump for five minutes, *once a week.* Do not pump any of the solutions, but wet the pump cylinders with water, and open drain cocks on fluid cylinders so that pump can run on air. Oil all working parts.

2. Agitate the solutions with air on the first Saturday of every fourth month for a period not exceeding three minutes. The foamite inspector will perform this test when he is making his tri-yearly inspection.

3. Test the pump for capacity and pressure on the first Saturday of every fourth month. For this test, fill the dissolving tank and take suction from there. Pump water from the dissolving tank and circulate the entire discharge through the relief valves. All valves on the pump manifold, except the dissolving tank suction valves must be closed during this test.

Note whether the pump will operate at a speed of 109.5 feet per minute, (36.5 revol. per minute) when working against a fluid pressure of 140 pounds per square inch on each end of the pump, the steam pressure being 112 pounds per square inch. (For this portion of the test, the water should be throttled through the bypass-to-suction valves).

At the conclusion of the tests, drain

the pump, and then close fluid cylinder drain valves. Open main discharge valves on the pump manifold. The leak indicator cocks on the suction and the return-to-suction valves should remain open at all times except when the pump is being operated. The foamite inspector will perform these tests when he is making his tri-yearly inspection.

4. All pipe lines should be subjected at least semi-annually to a hydrostatic test of 175 pounds per square inch.

5. All hose should be tested at least once a year, at from 100 to 125 pounds hydrostatic pressure. Water should be run through all rubber-lined hose, at least twice a year, to retard deterioration of the rubber lining. Drain all hose properly and replace hose on reel.

6. See that all apparatus connected with the foamite system is in its proper place and ready for instant use.

7. Make foaming and hydrometric tests of the foamite solutions once a month, as follows:

Foaming Test

POUR 25 c. c. of each solution simultaneously into a graduated cylinder of 500 c. c. capacity. The temperature of each solution should be 60° Fahr.—a maximum variation of one degree either way being permissible. The solutions should expand to at least seven times their original volume (combined). The foam should consist of fine, minute bubbles, well bonded together, be quite stiff, and, after several seconds of vigorous stirring, show no signs of collapse; that is, it should now show an expansion of at least six.

If the foam does not respond satisfactorily to this test, send one quart of each solution for examination and advice to:—Foamite-Childs Corp. Chemical Laboratories, Utica, N. Y.

The quart containers should be of glass or other acid-proof material (not metal), properly labeled as to contents and point of origin.

Hydrometric Test

FOAMITE solution A should have a specific gravity of 1.074 when taken at a temperature of 60°F. The specific gravity equivalent in degrees Baumé is 9.99.

Foamite solution B should have a specific gravity of 1.063 when taken at a temperature of 60°F. The specific gravity equivalent in degrees Baumé is 8.59.

8. Any evaporation from either A or B solution should be replaced by sufficient amount of clear, fresh water, to bring the solution to its standard specific gravity, as mentioned under hydrometric test."

9. Before freezing weather sets in, drain condensate from all pipe lines.

10. In latitudes where the temperature falls below 50°F., the heating system for the foamite solution tanks should be set in operation, and the temperature of the solutions maintained at about 60°F. during the entire cold season.

Charging Instructions

1. Foamite solutions should be made up as follows:

For each gallon of solution A, use: 1.16 pounds of aluminum sulfate (Foamite Chemical A). 0.935 gallons of clear, fresh water.

For each gallon of solution B, use: 0.265 pounds of firefoam liquid. 0.808 pounds of sodium bicarbonate (Foamite Chemical B). 0.945 gallons of clear, fresh water.

2. Determine the gallons of each solution to be added by gauging the solution storage tanks and using the data given below:

Data on Solution Tanks

Inside diameter .....25 ft.
Nominal capacity ....90,000 gallons
Present depth of solution (75,000 gals.) .....20 ft. 5 in.
Each inch of depth represents.... .....306 gallons

3. Calculate the weight of each chemical necessary to make up the amount of solution required.

4. Dissolve the aluminum sulfate in accordance with the following:

(a) Run 1 foot 9 inches of clear, fresh water into the dissolving tank and heat the water with steam to the maximum temperature which can be attained without causing discomfort to workmen on the grid cover.

(b) Agitate with air and add 8,000 pounds of aluminum sulfate, distributing it well over the tank.

(c) Stop air agitation and heat solution to boiling.

(d) Turn off steam, agitate with air and add clear, fresh water until the depth of solution is about 4 feet.

(e) Pump into solution A storage tank.

(f) Run clear, fresh water into the dissolving tank and continue pumping until the hot solution is washed out of the pump.

(g) Repeat the above operations until the required amount of aluminum sulfate has been dissolved.

5. Pump clear, fresh water into solution A storage tank until the solution reaches the depth specified under "Charging Instructions". Then agitate the solution in the storage tank with air for 10 minutes.

6. Wash the dissolving tank out thoroughly.

7. Dissolve the sodium bicarbonate in accordance with the following:

(a) Run 3 feet 9 inches clear, fresh water into the dissolving tank and heat to 120°F. This temperature must not be exceeded.

(b) Turn off steam, agitate with air, and add 2,400 pounds of sodium bicarbonate, distributing it well over the tank.

(c) Continue agitation for several minutes after the addition of the sodium bicarbonate, until the sodium bicarbonate is dissolved.

(d) Stop air agitation and pump into solution B storage tank.

(e) Repeat the above operations until the required amount of sodium bicarbonate has been dissolved.

(f) Agitate the solution in the storage tank with air for not more than three minutes.

General Notes

1. When charging the solution tanks the end of the pump opposite the end pump solution should have water circulating in it.

2. After charging, wash out the pump thoroughly and drain same. Make sure that no solution entered the field lines.

3. Temperatures above 120°F. make sodium bicarbonate solution give off its carbon dioxide gas, thereby reducing its fire extinguishing value.

4. Aluminum sulfate and sodium bicarbonate are packed in wooden barrels containing 400 pounds per barrel. Firefoam liquid is packed in steel drums containing approximately 490 pounds per drum.

In addition to the foamite system in use at the Parco, Wyoming, refinery of Producers & Refiners Corp. steam smothering lines are also installed at all tanks. These steam lines were in use before the foamite system was installed, but, thereafter, were not removed; instead they now serve as an additional means for fire protection. The steam lines on all tanks have remote controls. To simplify identification, numbers are marked on the steam lines to correspond with the numbers on the tanks.

Advantage in remote controls on the steam lines lies in the fact that in case of fire at one of the tanks, the operator can turn the steam into the tank without danger to himself. These remote controls are found in various parts of the refinery, where they are readily accessible to the operator.

The refinery fire department functions under the direction of a fire marshal, who devotes all his time to seeing that the plant's fire prevention policy is carried out, including the inspection of all equipment. Each department of the refinery furnishes an assistant to the fire marshal, and these men are then regularly instructed and drilled in the prevention of fires and the utilization of the equipment as it applies to their departments; thereafter, instructing other employees in their departments.

Chemical solution tanks, hose, ladders, etc., mounted on an automobile chassis further supplement the fire-fighting equipment at the Parco refinery.

Contact Filtering is an Individual Problem for Every Refinery

By Max B. Miller

THE variety of crudes from which lubricating oils are made, the wide range of specifications for finished product, and the numerous methods employed in the preparation of the stocks, each serve to limit any brief discussion of the various processes of contact filtration to generalities. The following, therefore, will deal only with some of their salient features.

Processes of contact filtration were originally developed because of two fundamental facts: First, it was found that the efficiency of an adsorptive material depended upon the intimacy with which the impurities of the oil could be brought into contact with the material utilized for their adsorption. Second, that the intimacy of the contact depended upon the degree of fineness of the adsorptive material utilized as well as the fluidity of the oil to be treated.

Consequently, inasmuch as it was impossible to pass an oil which had been heated sufficiently to develop its greatest degree of fluidity through a bed of adsorptive material ground to fineness which would render its greatest efficiency in accordance with the accepted method of percolation, the procedure of contact filtration was developed.

There are certain basic steps employed in each of the various processes of contact filtration which may be described very briefly as follows:

The adsorptive material (various clays are utilized for the purpose) is ground to a high degree of fineness. It is added to the oil and is incorporated in it by thorough mixing. The mixture is then brought to a high temperature which reduces the viscosity of the oil and permits the most intimate contact between the decolorant and the impurities. After heating the oil is cooled and the clay is removed by mechanical means. The clay-free oil is the finished product.

Color Control and Plant Flexibility

TWO of the most important features of the processes of contact filtration are:

1. The ability it gives the operator to control the color of his finished product, and

2. Extreme plant flexibility which permits the production of oils of almost any desired color without the curtailment of full plant capacity.

In the operation of a percolation filter plant, the color of the finished product is a composite of oils brought to both a high and a low color. The operation is carried on until the composite is correct. The amount of filtering required cannot be determined beforehand. The operation requires constant adjustment, constant care and frequent rehandling.

MAX B. MILLER

Mr. Miller was graduated as civil engineer Swarthmore College, Class 1909. *Saw service as civil engineer Isthmian Canal Commission in Panama and Northern Pacific Railroad in Northwest. Participated in the formation of The Sharples Specialty Co. in* 1915. *Became vice president of that company. Organized Max B. Miller & Co., Inc. in* 1923. *Now president of that company.*

In the process of contact filtration the color of the finished product is controlled by the quantity of clay mixed with the oil. The more clay the better the color or vice versa. The quantity of clay to be utilized for a certain color is determined beforehand in the laboratory, so that the operator can by the addition or subtraction of the quantity of decolorant mixed with the oil operate at the full capacity of his plant and produce as a result an oil of a color no matter what the requirements may be.

Uniform Decolorization

From the above it is seen that whereas a percolated oil is a mixture of oils which have been brought to a variety of colors, contacted oils are decolorized equally and uniformly throughout.

The effect of this has manifested itself in a rather interesting manner in connection with the operation of those contact plants which are utilized for filtering stocks which are subsequently dewaxed by the Sharples process.

It is generally known that color bears a direct relation to wax precipitation. The wax content of an oil filtered to a high color will precipitate more readily than will the wax contained in an oil of darker color.

In the operation of the contact and Sharples plants it has been found that the waxes in a contacted oil brought to a definite color precipitate more readily than do those contained in a percolated oil of similar color.

This fact has been attributed to the uniform decolorizing ability of the contact process. It manifests itself in permitting the production of a finished product of much lower cold test and in the yield of a separated wax which contains much less mechanically entrained oil.

The Relation of Acid Treatment to Contact Filtration

IN BRINGING the oils made from a mixed base or an asphalt base crude to color, the major portion of the work is accomplished by treating with sulfuric acid. Where filter plants employing the percolation method are utilized for the subsequent filtration of such oils the acidity of the oil is neutralized chemically before the oil is delivered to the percolation plant.

Where oils of this character are subsequently filtered by the contact process the clay is put upon the acid oil without prior neutralization. The clay consequently acts as an adsorptive for the acid as well as a decolorant. The result is accomplished in a single dose or in other words, the two reactions, if they may be called that, are carried on simultaneously. This phase of the process of contact filtration not only eliminates the step of chemical neutralization—a process that has always given trouble—but is responsible for the production of an oil of very much better outer tone.

Chemical neutralization of an acid oil is sometimes responsible for the formation of compounds the removal of which is very difficult. Where the clay, however, is put upon the acid

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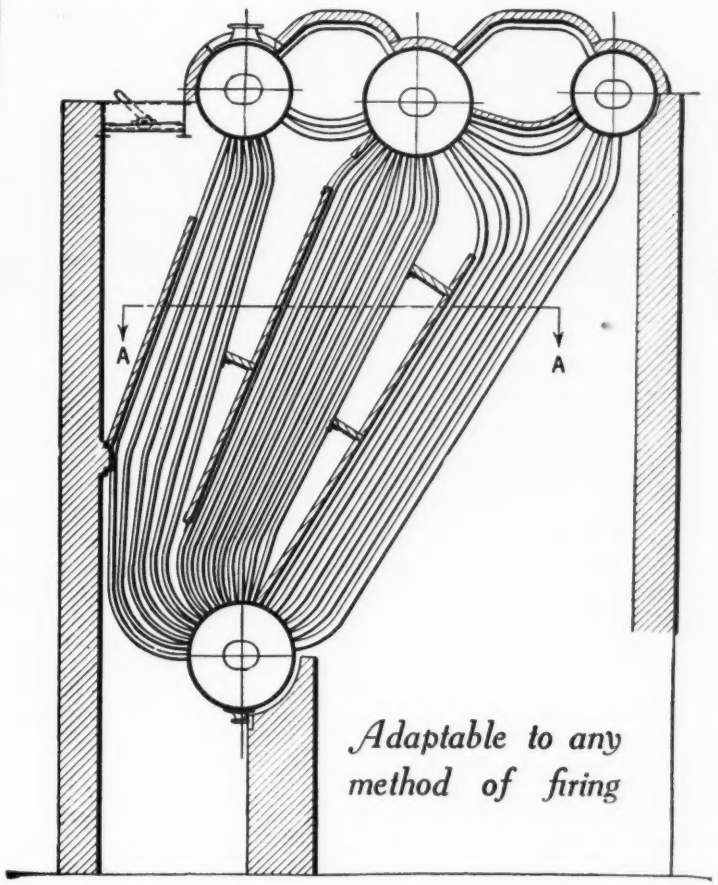

Vertical cross section through Heine V Type Boiler

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oil there is no reaction. The acid is adsorbed by the clay. The action is purely mechanical. No chemical compounds remain in the oil for subsequent removal. The improved result is visible to the eye.

The Efficiency of Adsorptive Material

IN CONSIDERING the construction and operation of a plant employing the process of contact filtration the selection of the adsorptive material to be utilized is most important. In most cases the clay of the highest possible efficiency, that is, one which will decolorize the greatest amount of oil per ton of material, should be used.

This is true even though the cost of the more efficient material may be considerably higher than a material of low efficiency. A material of low efficiency even though it costs less requires more clay handling equipment, more clay storage, more equipment for processing, greater capacity for removing it and what is of still greater importance, is responsible for a greater loss of oil due to the absorption of the oil in the spent clay.

The efficiency of adsorptive material, therefore, not only effects economy in plant operation but controls to an enormous degree the plant investment requirements.

The Pulp Process

THE extremes to which it is economically feasible for one to go in securing a decolorant of the highest possible efficiency is exemplified by the utilization of the so-called pulp process of contact filtration.

This process was particularly developed for the filtering of heavy residual oils such as long residuum and steam refined stock from which Sharp stock and bright stock are respectively manufactured.

It is called the pulp process because of the characteristics of the adsorptive material. This material is a product resulting from the activation of Montmorillonite with sulfuric acid. The development of the use of the material in the pulp form is of considerable interest.

Some years ago it was found that materials of this class if activated with sulfuric acid produced a decolorant of the highest efficiency. Originally, however, it was the practice after acid treating to dry the resulting mud, to grind it and to put it upon the oil in the dry form. However, it was found that the drying of the mud and the grinding of the dry material killed to a certain extent the decolorizing efficiency of the resulting product and, of course, these two operations added expense to its cost.

Consequently, the idea of treating the raw material at the refinery, of putting the treated material on the oil in the pulp form, of drying the pulp or mud in the presence of the oil was developed with the result that the cost of producing the decolorant was reduced and a product of the highest possible efficiency made use of.

It cannot be denied that the utilization of such a process entails somewhat greater plant investment and institutes operations of some slight complication but the fact remains that the efficiency of the resulting material when applied to these heavy oils is such as to warrant the procedure not only from an economic point of view but because of the excellence of the color and outer tone of the finished product.

Contacting During Distillation

ONE of the most interesting developments in connection with the process of contact filtration has been that in which the decolorant is put upon the oil during the process of its distillation. This particular departure was originally conceived for the filtration of residuums from Pennsylvania crude. It may, however, be utilized in a number of different ways:

1. In connection with the filtration of overhead stocks in which the oil is being reduced to a final specification after initial distillation.

2. For the filtration of oils that have been diluted prior to acid treatment in which the clay may be put on the oil at the time the dilution is being stilled off.

3. In connection with the filtration of residuums made from mixed base crudes wherein the crude or the topped crude has been acid treated, neutralized and the clay introduced during the process of reduction of the treated oil.

The first plant to be put into operation for contacting during distillation was utilized in connection with the manufacture of dewaxed long residuum from Pennsylvania crude. A brief description of the manner in which the plant is operated will give a general idea of the manner in which this particular method may be applied to any one of the oils referred to above.

The distillation of the crude which requires no acid treatment is carried on by circulating the crude from a separator tank through the coil of the pipe heater and back into the separator tank again. The circulation is carried on until the crude is reduced to required specification. The clay to be utilized for decolorization is made into a paste with a certain amount of oil. When the temperature of the oil being distilled has reached 350° F. or higher the clay and oil paste containing sufficient clay to give the desired color reaction to the ultimate residuum is pumped into the distillation system.

The mixture is slowly added so that by the time the oil has been reduced to specification the entire charge of clay has been incorporated in the oil. When the oil has been reduced to specification the clay-charged oil is then pumped from the separator tank, cooled and the clay removed. [The plant where this process is being carried on was described in the June 8 issue of NATIONAL PETROLEUM NEWS, page 85.]

Where pipe stills are installed by which the overhead stocks are flashed off in a single pass the clay can be added to the hot residuum at the completion of the distillation with equal efficiency.

Thus the process of the distillation of the oil, the process of contacting, is carried on in the same apparatus, at the same time, so that the cost of operation is not only curtailed but the investment requirements reduced to a minimum.

The Contact Filtration of Overheads

ONLY the more recent developments of the processes of contact filtration have been mentioned above. As a matter of fact, these procedures are really the outgrowth of the process as it was originally developed which was primarily for the contact filtration of overhead stocks.

The procedure in connection with the contact filtration of overhead stocks varies with the character of the oil. However, the decolorant is put upon the oil in the dry form in all instances. In general, there are three different applications:

1. For the decolorization of the overhead stocks which have been acid treated in which the decolorant is put upon the acid oil without prior neutralization;

2. For the decolorization of overhead oils which have not only been acid treated but have subsequently been wholly or partially neutralized by chemical means.

3. For the stabilization of color wherein no definite color cut is made by the adsorbent but where the clay is put upon the oil for the purpose of preventing the oil from going off color.

The manner in which the clay is applied to the oil in all three of these applications is substantially the same. The clay is mixed with the oil. The mixture is brought up to high temperature. The clay is removed either before or after cooling.

In Conclusion

In concluding these remarks the writer cannot refrain from saying that in his opinion the processes of contact filtration are not subjects for general discussion. They are rather problems for particular investigation and consideration in each refinery. Their value can be determined only after conditions in the refinery proposing to install them have been thoroughly gone into.

Pumps the Most Vital Equipment Items In All Branches of Oil Industry

By F. B. Applegate

PUMPS are probably the most essential single item of equipment that is necessary for the production, transportation and refining of petroleum and its products. Practically every type of pump manufactured, from the most simple water pump to the highly special types such as the slush, trunk line and hot oil pumps, are used somewhere in the oil industry.

Pumps may be divided into displacement types, either steam or power driven, and centrifugal and rotary types which may be direct connected to, or belt driven from a prime mover or line shaft. Each type has its distinct advantages, and one type of pump will be found to be better adapted to some particular service than a pump of another type.

Steam driven displacement pumps of either the single or duplex types are of low first cost, simple in construction and are unequaled in their flexibility as to speed, capacity and their ability to handle either light or heavy oils against any discharge pressure up to the maximum for which their liquid ends are designed. When the service requires, they may be automatically controlled by suitable speed and pressure governors and may always be protected by an excess pressure governor from any damage that would result from the sudden closing of the discharge valve.

Power driven displacement pumps of the single, duplex or triplex types are highly efficient machines. The initial cost of such equipment is higher than either steam driven displacement or centrifugal pumping equipment. They are suitable for a wider range of operating conditions than centrifugal pumps and when driven by variable speed DC motors or the recently developed variable speed AC motors, they are quite flexible in their operation.

The centrifugal pump has been perfected to a point where it has become a high efficiency machine for pumping water, light distillates and crude oils of low viscosity. Its field of application in the oil industry, however, is not fully known and experiments are constantly being made which will enable manufacturers not only to expand its field but also to establish the limits of its application to oil pumping. Motor driven centrifugal pumps are constant speed machines of fixed head capacity characteristics. The speed of steam turbine driven centrifugal pumps can be changed giving the pump a degree of flexibility which, however, cannot be compared to that of the steam driven displacement pump.

A centrifugal pump that has been designed for handling water or light distillates, will not handle heavier oils with any degree of economy, and in many cases will not handle them at all. A centrifugal pump properly designed will not damage itself or its motor should the discharge valve be closed before the pump is shut down.

F. B. APPLEGATE

Mr. Applegate began his engineering career at 16 with a pick and shovel, worked then as a stationary fireman and for a short time in engine room. Went to work for Crocker-Wheeler Co. as tracer and detailer and worked nights learning armature winding. Abandoned electrical work to become draftsman with International Steam Pump Co. Took course at Columbia University in bridge designing but decided pump business was more appealing and went to work for Worthington. With that company he has been successively designer, foundry chemist, estimator and in 1922 was promoted to sales engineer in charge of direct acting pump and feed water heater department, specializing on pumps and equipment for the oil industry. Fishing for channel bass and tuna is his hobby. He is shown here with one of his victims.

Selection of Pumps

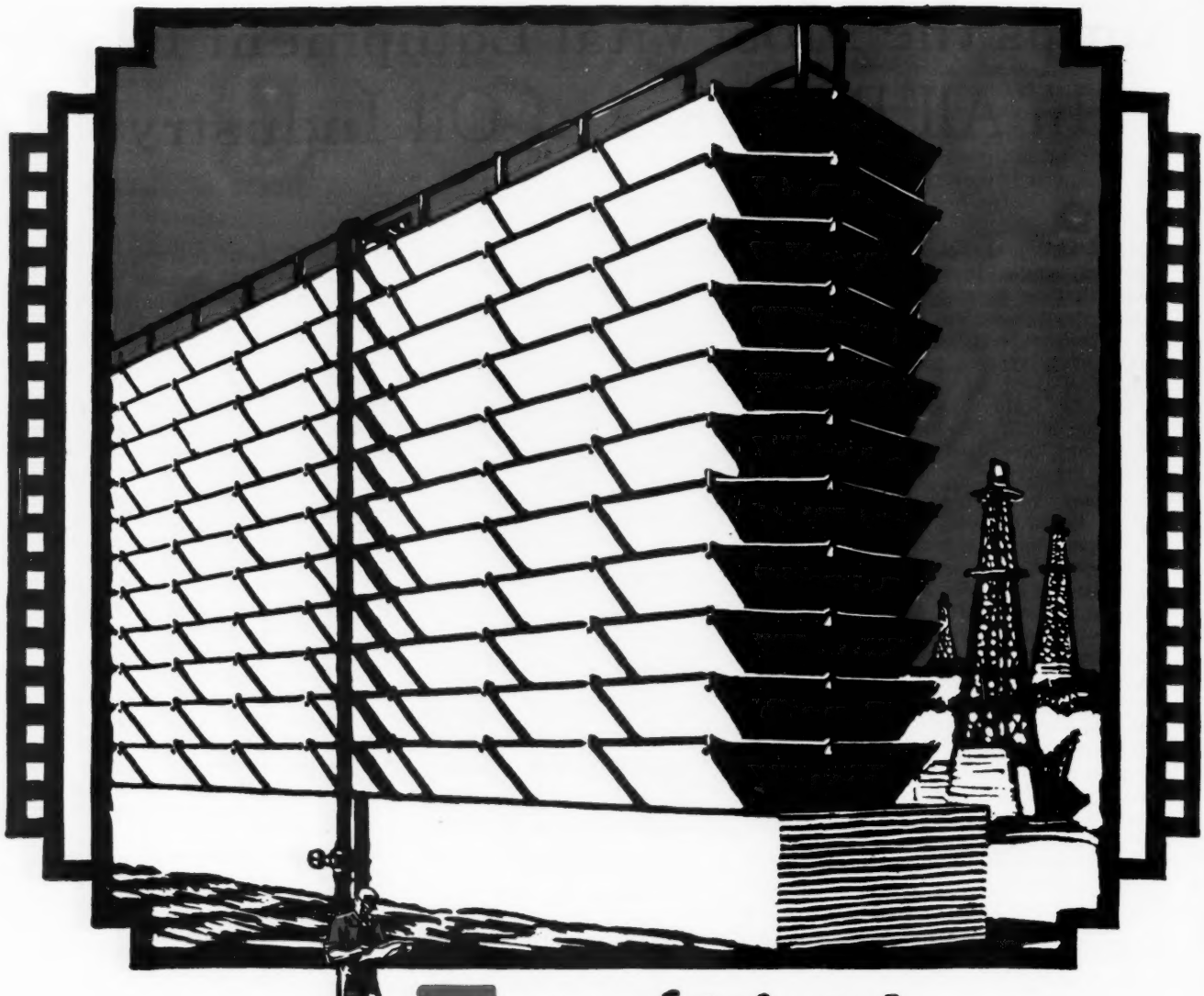
NO FIXED rule can be made to govern the selection of pumping equipment for all conditions of service. Each case must be considered by itself and a selection made that will give the most efficient and economical unit for that service. If electric power is available in the field or if a short transmission line can be carried to the field at small cost, electric driven power pumps may be used to advantage. The question of fuel and water supply and the necessity of preheating oil before pumping will determine whether steam or Diesel engine driven pumps should be used in a pipe line station.

The cost of electric current, the relative location of existing transmission lines and pumping stations or the necessity of new transmission lines and their cost will govern the selection of electric driven or Diesel engine driven pumps for pipe line stations.

In the refinery all types of pumps are used and their selection does not depend solely upon the service to be performed, but to a great extent upon operating conditions in the refinery itself. If the amount of exhaust steam from the main and auxiliary equipment does not provide a sufficient amount for process work, steam driven pumps will be the most economical type. The cost of operating steam pumps under these conditions is a small item of expense as the pump simply acts as a reducing valve and the useful work performed becomes a by-product of the steam generated for process work.

Steam driven displacement pumps will always be the most satisfactory if one pump is required to handle both light and heavy oils or any grade of oil over a considerable range of capacities and pressures. If the amount of exhaust steam exceeds the process requirements and electric current is available either power driven displacement pumps or centrifugal pumps may be used to advantage to supplement the steam driven pumps.

When bleeder type turbines are used for driving the main generators, steam for process work is taken from the intermediate stages of the turbine. In this case the electric current becomes the by-product and is used



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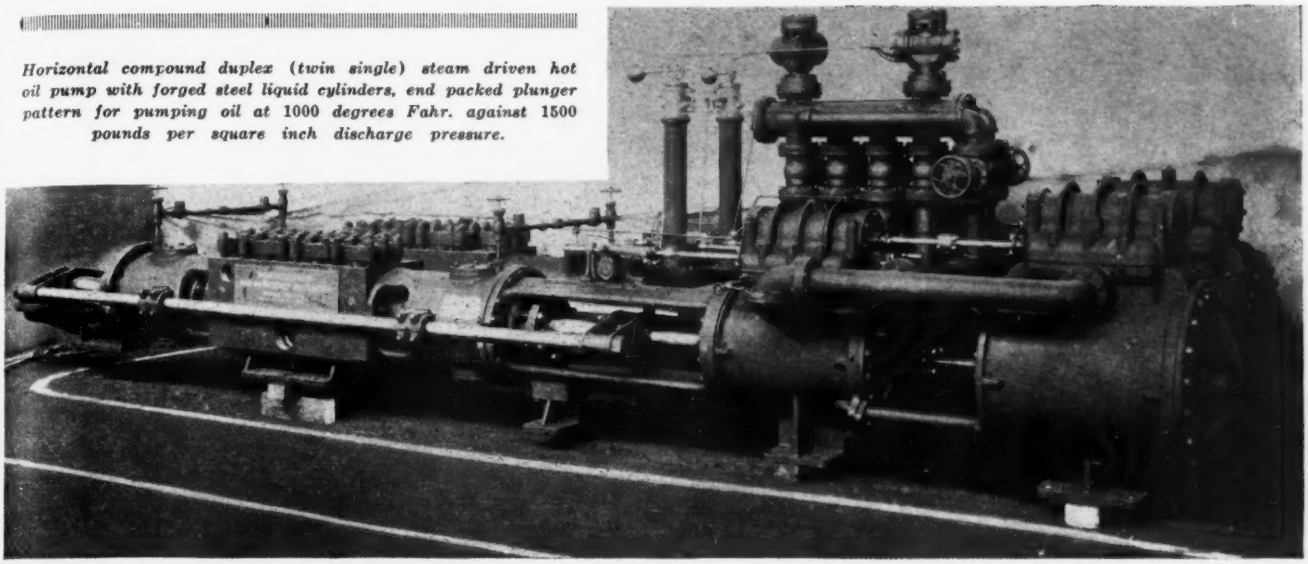


Horizontal compound duplex (twin single) steam driven hot oil pump with forged steel liquid cylinders, end packed plunger pattern for pumping oil at 1000 degrees Fahr. against 1500 pounds per square inch discharge pressure.

to drive the pumping equipment. Power driven displacement pumps and centrifugal pumps are used almost exclusively under such conditions, steam driven pumps being used only where the service conditions cannot be met with other types.

If a pump is required to operate against a high pressure with the minimum of pulsations in the discharge line, for example, pumping chilled wax to the press, the triplex single acting power pump will give the best results. Centrifugal pumps will prove the most economical type to use in many places around the refinery for pumping water and liquids of similar viscosity and for pumping light distillates and oils of low viscosity to the loading racks.

It is of course impossible in an article of this kind to adequately describe all types of pumps used in the oil industry so we will confine our discussion to the most recent developments which will be of interest to each branch of the industry.

Slush Pumps

THE heavy rotary drilling rigs in use today call for slush pumps that are larger, heavier and more economical in their use of steam than the pumps formerly used for this work. The latest development is the compound slush pump of 18-inch stroke. The long stroke pump will handle the same volume of liquid with fewer reversals than the short stroke pump without affecting the discharge pressure in any way. Decreasing the number of reversals also decreases the number of times the liquid valves must open and close, increases the useful life of the valves, valve seats and all other working parts of the pump.

The compound steam end is suitable for steam working pressures up to 225 pounds per square inch. Compounding the steam end adds to the economy by decreasing the steam consumption and gives the added advantage of increasing the discharge pressure for breaking out an obstruction by simply opening a by-pass valve and admitting steam at full boiler pressure directly into the low pressure steam cylinder. This avoids wasting time that would otherwise be spent in replacing the larger diameter liquid pistons and liners with the smaller ones necessary to produce the required pressures.

To illustrate the operating advantages of compounding the 18-inch stroke slush pump let us compare the 14x7x18 simple pump with the 12&18x7x18 compound pump both supplied with steam at 150 pounds pressure at the pump and discharging at the rate of 300 GPM and exhausting to the atmosphere. The mechanical efficiency of a pump of this size and type would be 80 per cent. The discharge pressure would be equal to the steam load x the mechanical efficiency ÷ by the area of the liquid piston. The 14-inch steam end would have a steam load of 14^2 x .7854 x 150 x .80 = 23085 pounds. The discharge pressure would be 23085 ÷ 7^2 x .7854 = 480 pounds per square inch. The 12 & 18 compound steam end will have a steam load of 19246 pounds and the discharge pressure would be 19246 ÷ 7^2 x .7854 = 500 pounds per square inch. If for any reason it becomes necessary to increase the discharge pressure, steam at 150 pounds pressure can be admitted to the low pressure cylinder and the discharge pressure boosted to 18^2 x .7854 x 150 x .80 ÷ 7^2 x .7854 = 795 pounds per square inch without reducing the capacity or stopping the pump to change the liquid pistons and cylinder liners.

This same discharge pressure could be obtained with the simple pump either by raising the steam pressure to 250 pounds per square inch or by inserting 5¾-inch diameter pistons and liners in the liquid end. The latter course means loss of time and capacity as the pump must be shut down to make this change and with the smaller liquid pistons the capacity will be reduced 41 per cent unless the pump be operated at excessive speed which means excessive wear.

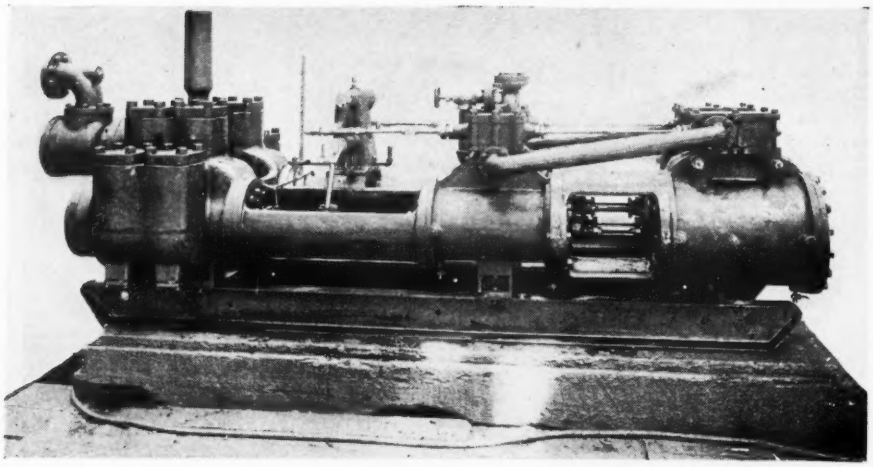
The saving in steam by compounding amounts to 35 per cent and by using the new portable feed water heater the fuel saving may be brought up to 43.7 per cent. To illustrate, we will compare the simple and compound pumps operating under the same conditions of service.

	14x7x18	12&18x7x18
Capacity GPM	300	300
Discharge pressure	480	480
Steam pressure	150	150
Water HP	84	84
Steam consumption Pump HP hr.	80	52
Total lbs. steam per hr.	6720	4368
Fuel used in lbs. per hr. ..... (evaporation 8 to 1)	840	546
Lbs. steam saved....	.....	2352
Lbs. fuel saved	.....	294
Saving in per cent (Fuel & Steam)		35
Fuel used lbs. per hr. by heating feed water from 60 deg. to 210 deg. F.		472
Total fuel saved by compounding and heating feed water		368 lbs. or 43.7%

Assuming the compound slush pump and feed water heater are only operated 10 hours per day and 300 days per year the fuel saving would amount to 552 tons. The saving in dollars will of course vary, depending upon the fuel used and the cost per ton.

Portable Feed Water Heater

The portable feed water heater mentioned in the preceding paragraphs, consists of a vertical cylin-



Compound duplex slush pump, size 12 & 18 x 7 x 18. Capacity 340 gallons per minute against 600 pounds per square inch discharge pressure. The liquid end piston rods are lubricated from a central reservoir located in the pedestal supporting the steam valve gear.

drical steel shell open type heater mounted directly over two horizontal single piston pattern boiler feed pumps. The skids for the pumps and the supports for the heater are made up of standard structural steel members. The total weight of the outfit including the two pumps is only 3500 pounds.

When provided with sufficient exhaust steam the heater will supply 10350 pounds of hot feed water per hour, which is sufficient for 300 HP of boilers at 34.5 pounds evaporation. The 6½ x 4⅛ x 8 feed pumps are good for 250 pounds working pressure on both the steam and liquid ends, and each pump is capable of feeding 300 HP of boilers at normal rating. One pump is always in reserve and is ready to take up the load should one pump be down from any cause.

The feed water heater is provided with an oil separator, water sealed overflow, filter for purifying the hot feed water, and an automatic cold water inlet valve actuated by an open float. The entire unit is simple, compact, easy to clean and the open float eliminates all troublesome shut downs caused by the collapse of ball floats.

In regions where bad feed water is encountered, the feed water heater can be used to advantage to purify the feed water. Mud and silt contained in the raw water is removed by the filter in the bottom of the heater. Considerable quantities of scale forming impurities such as iron, carbonates of lime and magnesia can be precipitated in the heater by heating the raw water to 200-210 deg. Fahr. This purification of boiler feed water will not only reduce the time lost for cleaning boilers, but will keep both the fuel and repair bills down as a clean boiler requires less fuel and less repairs than a boiler that is badly scaled.

Power Pumps

Power pumps when operated in the open where they are exposed to dirt of all kinds are subject to excessive wear unless the moving parts are well protected. The fully enclosed power pump has been developed expressly for field service and all of the moving parts are protected by a dust, dirt and oil proof case. A pump of this type may be operated in the most exposed places without dust or grit finding its way into the gears or bearings, except through carelessness of the operators.

A large oil reservoir in the crank case provides automatic flood lubrication for all bearings and moving parts. The fully enclosed power pumps may be belt driven or direct connected to electric motor or gasoline engine, whichever is most convenient. They are built for discharge working pressures up to 1000 pounds per square inch and are suitable for water supply, cementing wells, gathering pumps, etc.

Power pumps direct connected to Diesel engines are used almost exclusively in new oil line pumping stations all over the country. The Diesel engine is the nearest approach to a self-contained power plant that has been developed, as it is not dependent upon large, expensive auxiliary equipment for its successful operation. Its low operating costs and low standby charges make it the ideal driving unit for oil line power pumps. The amount of fuel entering the cylinder is controlled by the governor and is practically proportional to the horsepower demands. The cost of operating a Diesel engine driven trunk line power pump with fuel oil at $3 per barrel and lubricating oil at .50 per gallon is $1.55 per day per 1000 barrels of oil pumped against 700 pounds line pressure. There are no standby fuel losses, as the Diesel engine when idle is shut down completely, and is always ready to start and pick up its full load in a few minutes.

Power pumps with forged steel liquid ends for oil line service have many points of superiority when compared with pumps having liquid ends of either iron or steel castings. The use of steel forgings that are perfectly homogeneous eliminates leakage and sweating, reduces pressure joints to the minimum in number and maximum in tightness, reduces the number of gaskets on the pressure side of the pump as nearly all joints are metal to metal. The suction and discharge valves are located so as to give a short straight flow of oil through the pump as opposed to long crooked passages and reversal of flow as in some types of pumps with cast liquid ends. The valves are hardened steel balls and operate on renewable seats of either hard bronze or steel. The forged steel liquid end is absolutely dependable and is proof against breakage from either line or shock pressure.

Centrifugal Pumps

THE application of centrifugal pumps to oil pumping requires the most careful consideration. In nearly all cases the pump will require fittings that are suited to that particular service, for example, for pumping gasoline, the shaft sleeves must be of steel and the stuffing boxes must be of a special design to prevent excessive heating and excessive leakage. Each problem must be carefully analyzed and the selection carefully made if the best results are to be obtained from the installation.

The late models of general service high efficiency ball bearing pumps embody many refinements in casing and impeller designs. These centrifugal pumps develop and sustain in service efficiencies that are 8 to 10 per cent higher than the average centrifugal pump when handling water, kerosene, gasoline or other light distillates.

A number of experiments have been made in the testing laboratory of the Worthington Pump and Machinery Corp. to determine the economical application of centrifugal pumps to oil pumping. These tests show that when pumping oil, the economy of commercial types of centrifugal pumps was very low, and that casings and impellers of special design would have to be developed if any degree of economy was to be obtained with centrifugal pumps for oil service. Tests were then made with casings and impellers of various designs which led to the development of multi-stage centrifugal pumps that are suitable for loading stations, pipe line and booster stations, and will handle oils up to 1000 seconds Saybolt Universal viscosity with efficiencies as high as 75 per cent. A number of these multi-stage pumps have been installed and are giving very satisfactory results, pumping 25,000 barrels per day against 350 pounds line pressure. The pumps are installed so that any two

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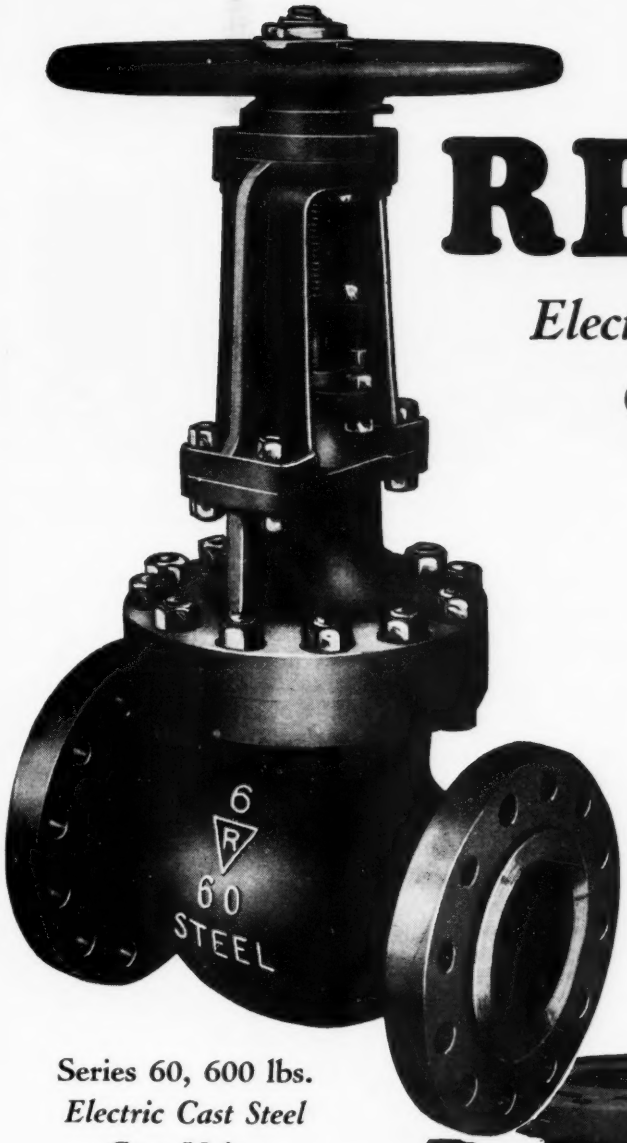

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may be operated in series against a line pressure of 700 pounds per square inch.

Worthington also developed an automatic control for use with centrifugal pumps in booster stations. This control, which minimizes station attendance, can be set to operate at any predetermined low and high pressure and will automatically start and stop the pumps when the pressures in the pipe lines reach these points.

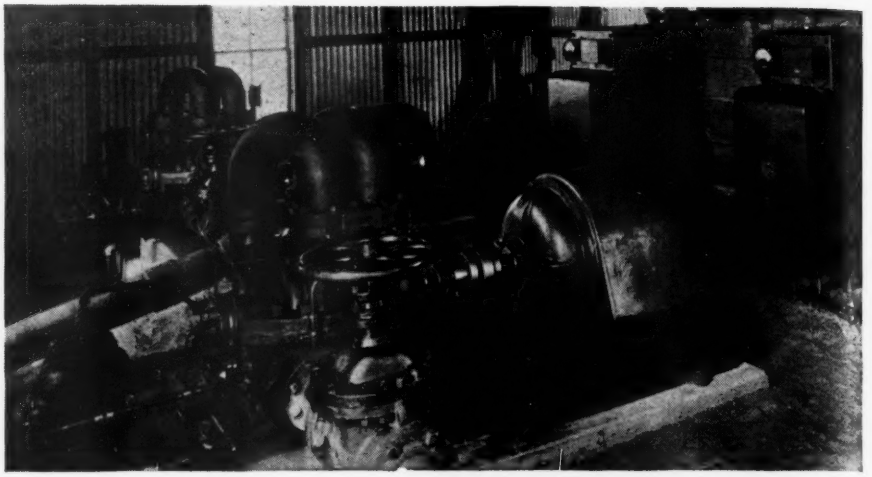
Hot Oil Pumping

WITHOUT question one of the most perplexing problems that has confronted refiners and pump manufacturers alike is pumping oils at high temperatures and at both high and low pressures. Pumps for hot oil service must not only be dependable in operation but they must be safe. The requirement of "safety first" involves not only the question of design but also the selection of the proper metals for use in the liquid end. The performance of hot oil pumps and their maintenance cost are largely determined by the quality of the materials used in the liquid end, and the selection of metals must be carefully made, keeping in mind not only the operating temperatures and pressures, but also the ability of the metal to withstand the corrosive action of some oils at high temperatures.

Tests show that cast iron does not lose its strength when subjected to high temperature for a short time; however, actual service conditions show that iron castings are not reliable for heavy pressure work at temperatures above 525 deg. Fahr. Iron castings may be safely used for light pressures at temperatures between 525 deg. Fahr. and 650 deg. Fahr., but above 650 deg. Fahr. changes take place in the molecular structure of cast iron, which make it unsafe to use this metal for pressure castings.

When considering either steel castings or forgings for the liquid ends of hot oil pumps, there is a tendency to overemphasize the tensile or ultimate strength of the metal and to pay little or no attention to its yield point or elastic limit. The yield point is the factor which will determine the maximum pressure for which a steel can be used under temperature, as the yield point is the maximum stress which the material will withstand without permanent alteration in form. The yield point and the elongation are two very important factors to consider in selecting steels for studs and bolts.

The physical properties of a good high grade cast steel would indicate that the metal could be used extensively for the liquid ends of hot oil pumps. Liquid cylinders, no matter how simple their design, require a



Multi-stage centrifugal pumps in pipe line pumping station. Capacity each pump 25,000 barrels a day against 350 pounds line pressure. Two pumps in series will deliver 25,000 barrels per day against 700 pounds line pressure.

number of cores, some of them quite small, and there is always the possibility of a core shifting and leaving a thin section which is likely to rupture when the pump is under temperature and pressure. Then, too, there is always porosity to contend with. Hot oil will leak through the most minute pores and castings that are perfectly tight when cold, due to porosity, will sometimes smoke badly when in contact with hot oil under pressure. As there is no positive way of detecting defects of this nature before the pump is in service, and as they do not always show up until after the pump is in service for some time, the use of cast steel liquid ends should be avoided as much as possible.

Steel forgings are ideal for the liquid ends of hot oil pumps. The forgings are homogeneous, there is no possibility of leaks on account of porous metal, their strength is always in excess of the actual requirements, and all liquid passages are bored from the solid eliminating all risks of thin sections, liquid passages are short and arranged to give straight line flow.

Limitations of Temperature and Pressure

THE following table will give the discharge pressures for which it is safe to operate pumps continuously with cast iron, cast or forged steel liquid ends.

Temperature Deg. F.	C. I. liquid end per cent	Cast steel liquid end per cent	Forged steel liquid end per cent
Up to 525 deg. F....	100	100	100
526 to 550 deg. F.....	90	90	100
551 to 600 deg. F.....	70	70	100
601 to 650 deg. F.....	50	50	100
651 to 700 deg. F.....	10	25	100
701 to 1000 deg. F..	0	0	100

A cast iron liquid end that is good for 200 pounds per square inch working pressure may be used for that pressure up to 525 deg. Fahr.; 180 pounds up to 550 deg. Fahr.; 140 pounds up to 600 deg. Fahr.; 100 pounds up to 650 deg. Fahr. which may be considered its useful limit as it is only good for 20 pounds at temperatures above 650 deg. Fahr. and should never be used for 700 deg. Fahr. A cast steel liquid end may be used for 25 per cent of its normal working pressure at 700 deg. Fahr. or a few degrees above, but 700 deg. Fahr. should ordinarily be considered the limit.

In emergencies, cast liquid ends may be operated for short periods at temperatures and pressures 50 per cent or more in excess of their continuous service ratings.

Forged steel liquid ends are only confined to the temperature and pressure limits of the remainder of the equipment. Forged pumps are now in operation at temperatures up to 980 deg. Fahr. and pressures up to 1250 pounds which are about the maximum so far obtained in actual practice. While it is true that in the near future, cracking may be done at higher temperatures and pressures than are known today, it is safe to say that a forged steel hot oil pump will be built to meet the most extreme service requirements.

Types of Hot Oil Pumps

THE displacement pump of the single or duplex type steam or power driven has proven the most satisfactory for handling hot oils. Centrifugal and rotary pumps have given fair results with oils up to 600 deg. Fahr. with light or medium discharge pressures, but the results with oils above 600 deg. Fahr. and heavy discharge pressure leave much to be desired. While it cannot be said that they are failures, much development is necessary before they can be considered successful. Multi-stage pumps for high pressures not only present serious problems in the prevention of leakage between stages, and through the stuffing boxes, but they present

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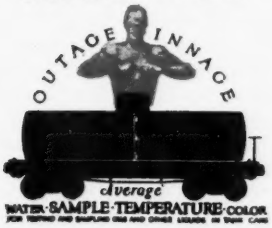

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The Mayhall Gauge

A portable and accurate instrument for testing and sampling oils in tank cars.

This gauge is conveniently portable, weighing between twelve and thirteen pounds, manufacturerd from high-grade materials that will not corrode or rust.

It is mechanically operated, simple and practically foolproof and we have recently been granted government patents.

It will trap three samples of approximately 230 CC's each at the top, middle and bottom any distance from the shell that is desired.

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From practical experience we feel that the average accurate temperature obtained by this gauge is one of its most important accomplishments. It is generally conceded by authorities who have studied the subject that average temperature is impossible to get under present procedure, and that it is most important. In fact, all the tests performed by this gauge are absolutely necessary and important, in determining the volume and correctness of the oil shipped or received, and it requires less than five minutes time. This method and principle is approved by the leading authorities.

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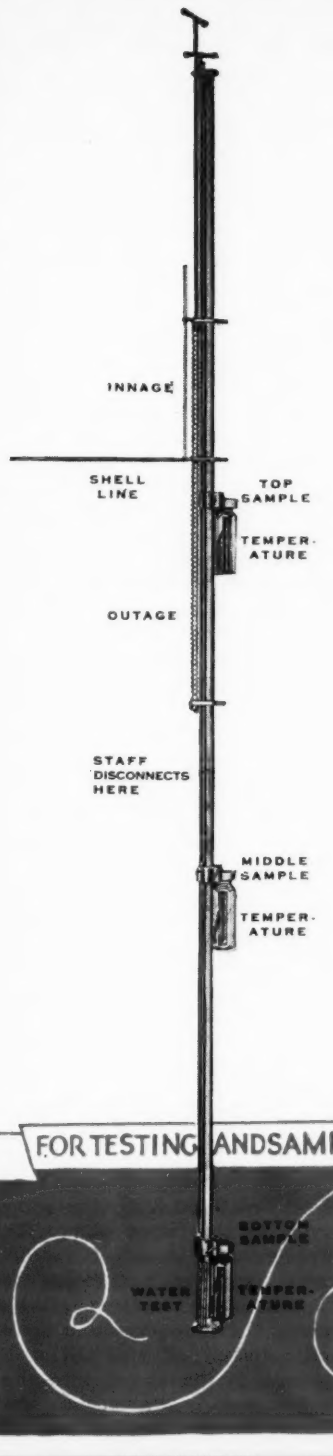

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serious problems in shaft deflection and shaft bearings. These problems are receiving the most serious consideration by manufacturers and a solution will eventually be found that will greatly extend the field of application of centrifugal hot oil pumps.

Steam driven hot oil pumps may be classified into the single, the duplex and the twin single. The steam ends of the single and duplex are the standard types. The single steam end will always make the full stroke and for this reason the single pump is the type preferred by many engineers as a single pump never short strokes on account of gas in the liquid end. Duplex steam ends of the large sizes are always fitted with cushion valves as this feature is essential for the close regulation of the stroke which is so necessary for hot oil pumps.

The twin single steam end consists of two standard single steam ends with standard steam valve gear placed side by side with a device to prevent them from coming into step with each other. There are a number of such devices now in use, one of the most simple and most flexible being an auxiliary steam chest with steam valves operated by a standard duplex steam valve gear.

This auxiliary valve chest is located between the right and left hand steam cylinders, and controls the admission of steam to each of the single steam chests from which point the standard single steam valve and gear controls the admission and exhaust of the steam in the main steam cylinder. The operation of the twin single steam end is similar to the standard duplex, but it has the added advantage that, when the pump is in operation should one side stop as the result of an accident or from any cause, the other side will continue to operate at slow speed until the operator is advised of the trouble.

By simply opening a throttle valve the operating side can be speeded up and run as a single pump to take care of the full load. This avoids taking a still off stream before the run is completed and by keeping the hot oil circulating will prevent coking up the tube bank. Twin single steam ends may be of the simple high pressure or compound types.

Liquid Ends for Hot Oil Pumps

FOR light pressure and medium temperatures cast iron liquid cylinders may be used. They may be fitted with cast iron or steel tube liners. The liquid pistons are cast iron and are fitted with either cast iron three ring or hammered iron packing rings. The valve service is of iron. For temperatures up to 450 deg. Fahr. springs are used for seating the valves. Above 450 deg. Fahr. springs lose elasticity and weighted valves that seat without springs are used. The liquid end stuffing boxes are made extra deep and may be cooled by circulating cooling oil inside the box, or they may be jacketed and cooled by circulating water through the jacket whichever is most convenient. The material used for gaskets depends upon the temperature, in most cases a good long fiber asbestos sheet will be satisfactory, occasionally it may be necessary to use aluminum cased asbestos gaskets. The liquid end piston rods are of hardened and ground steel. The rod packing may be asbestos with copper wire insertion or a good metallic packing, the latter being the most satisfactory.

All iron fitted pumps have given excellent service within their temperature limits with discharge pressures up to 500 pounds per square inch.

THE coefficient of expansion of all parts being the same, no trouble is experienced from parts coming loose when the pump is heating up or cooling off. In a few cases corrosion has made it necessary to use parts made from special metals, but these may be regarded as unusual. As an example of the satisfactory performance of all iron pumps, one refiner operated a 16x8x18 all iron piston pump handling 480 deg. Fahr. gas oil against 300 pounds discharge pressure, 24 hours per day for six consecutive months without a stop and then only shut the pump down to renew the rod packing.

When steel castings are used for the liquid end of hot oil pumps, the gaskets and other fittings are the same as used with iron pumps, that is, the liners may be cast iron or steel tubing, the pistons, piston rings, and valve service are of iron. If ball valves are used they may be of steel or iron.

For temperatures of 700 deg. Fahr. the forged steel pump is the preferred type for low pressure work and is essential for all temperatures above 700 deg. Fahr. and all high pressure work at 550 deg. Fahr. and above. Forged pump ends are made in both the piston and end packed plunger patterns, depending upon the discharge pressure for which it will be used. Either type may be attached to single, duplex or duoplex steam ends or standard power frames if electric driven pumps are desired. Piston pattern pumps are naturally lower in first cost and may be used for all discharge pressures up to 800 pounds per square inch. For pressures above 800 pounds it is difficult to keep the piston packing tight and the outside packed plunger pattern becomes the logical pump to use as leakage can be easily detected and the plunger stuffing boxes being outside are easily accessible and their repacking does not require a lot of time and excessive labor.

As forged liquid ends are used for the most severe service, their fittings are somewhat different than used with cast iron or cast steel liquid ends. The cylinder liners are of cast iron or steel hardened and ground. The iron liners will in general be the most satisfactory, the high temperatures in most cases offset the benefits of the hardening and the steel liner becomes little better than the cast iron and a great deal more expensive.

The liquid valves may be either the ball type or the semi-spherical type, bottom wing guided. The valve, valve seat and valve cage, if used, should be of stainless iron or stainless steel to prevent corrosion, as all oils have more or less corrosive action at high temperatures. When ball valves are used, a solid ball, of 2¾ to 3-inches in diameter has proven preferable. The small diameter balanced ball will revolve slightly each time it lifts and will seat on a different portion of its surface, which results in longer life and more uniform wear. The wear on the valve seat will also be less with the small diameter valve, as the area exposed to pressure varies with the square of the diameter, while the inertia of the valve varies as the cube of the diameter, consequently with a long discharge line filled with hot oil, which is an elastic liquid due to the entrained gases, the wear resulting from the pounding of the valve on its seat, will be less with the small diameter than with the large diameter valve.

Each valve compartment is bored to receive a steel plug which is not threaded, but is locked into position and the joint made tight by means of two heavy studs of alloy steel and a steel strongback. This construction makes it much easier to get at the valves as there are no threads to coke up and freeze.

All joints on the forged liquid end are made with male and female fitting and all gaskets used are aluminum cased asbestos. The liquid pistons, piston rings and liquid end piston rod stuffing boxes are practically the same as the corresponding parts used with cast iron liquid ends.

Forged Steel Plunger Pump For Hot Oil

PACKED plunger pumps for hot oil are fitted with the same valve service as the piston pumps, but they differ greatly in other details. The plunger stuffing boxes due to their size, are always water cooled and to prevent the plungers from smoking, a small amount of cold oil under low pressure, is introduced into the stuffing box and is drawn into the pump cylinder on the suction stroke, check valves being supplied in the cold oil supply line to prevent the oil from

entering the supply line on the discharge stroke of the pump.

The forging for the liquid cylinder has a square or rectangular center section, which serves as the valve chamber and the ends are cylindrical and extended the full length required for the plunger stuffing boxes. When the cylinder is finished the cylindrical ends are machined smooth on the outside diameter and the water jacket which is a separate iron casting is fitted over the cylindrical stuffing box section of the liquid cylinder and is bolted to the face of the center section or valve chamber. The inboard water jacket also acts as the connecting piece between the liquid cylinder and the steam end or power frame of the pump. The jacket casting is provided with a stuffing box and gland in each end which is packed against the water pressure only.

A water jacket of this type will provide adequate cooling, allow for the free longitudinal expansion and contraction of the cylinder without water leakage, and absolutely prevents any cooling water from entering the liquid cylinder as there are no joints to be packed against hot oil on one side and cold water on the other.

Inside of each plunger stuffing box there is a perforated spacer, one end seating against the bottom of the box, the other against the bottom ring of packing. The perforations permit the hot oil to come in direct contact with the water cooled surface of the stuffing box, and the length of the spacer permits the proper number of packing rings to be used for each box.

While the foregoing only treats in a general way of oil pumping, it is hoped that the description of recently developed pumping equipment will prove of interest to field and refinery engineers alike.

Development of Cracking Equipment and the Hot Oil Pump

Herewith are presented the observations of an engineer of wide experience in the development of equipment for the cracking unit, with particular attention to pumping equipment for hot oil.

THE history of the development of the cracking process is filled with harrowing experiences and it might be said that the individuals who carried on the earlier development literally went through "hell fire" with the determination to make the process a success. Only those who have had direct contact with this work can in any measure visualize the amount of effort that was required for this now accomplished task.

The fact that petroleum when subjected to high temperature and pressure will divide into various products and that the amount of lighter products is increased, has been known to the scientific world for many years but until the universal acceptance of the internal combustion engine for driving the automobile, there was no practical purpose in processing petroleum under the untold temperature and pressure conditions.

As the earlier experimenter did not have to establish the fact that petroleum could be changed into lighter hydrocarbons, his attention was immediately directed to the selection of a combination of elements in which the desired reactions could take place and to so arrange and combine these elements with various automatic controls as to insure the continuous production of products desired.

The sea of handling high temperatures and high pressures was as uncharted as the Atlantic was to Columbus when he first set sail. The doubters of the possibility of successfully handling such conditions were as numerous as the individuals approached for opinions and assistance. As Columbus was not to be daunted, neither were the men who realized the necessity of obtaining the increased yields from the petroleum.

The problem was one of the selection of material and equipment which would function with safety under the extreme conditions. When the problems were submitted to the material and equipment men, they at first threw up their hands in horror and said—"It can't be done." This opinion, although received many times and from every corner, did not deter the pioneers who had set out to give the public increased yields of products to meet the demands that were increasing at an unprecedented rate.

DUE to these fears in the earlier stages of development the experimenter had to assume the full responsibility of any material or equipment that was to be used in connection with a cracking unit and in some cases, the equipment men insisted on a signed release from any responsibility for any accident which might occur.

Progress was made in spite of these imposed handicaps, as a result the material and equipment manufacturers became bolder for they could see that some of their fears were unfounded and that here was a field in which little work had been done, but a field that offered vast possibilities. With this vision of the material and equipment man the road for the process man became much easier and brighter.

In the foregoing general discussion, an endeavor has been made to appreciate the difficulties that had to be met in the entire problem for it would be bad taste for anyone to discuss any one phase of this development without acknowledging the major problems.

A cracking unit consists of the following elements:

1 Heating element
2 Soaking drum or reaction chamber
3 Fractionating equipment
4 Automatic control apparatus
5 Circulating equipment

The earlier units were simpler than this as equipment was not available.

It is our purpose to discuss here the development of the circulating equipment which is as a matter of fact, the heart of the system, and a failure in circulation is fraught with many hazards, hence it is very important to select the type of equipment that will insure if possible, continuous operation.

Circulation was first accomplished by using the difference in specific gravity of the oil at the different temperatures existing in the system. This was a material application, for the circulation of water in a boiler for steam generation has universally been accomplished by this method. The heating of oil, however, is not as simple as heating water.

IN HEATING oil to high temperatures, we meet first the fact that the rate of heat transfer into the oil is very slow, thus requiring high heat differentials between the bases of combustion and the oil. With these high heat differentials existing, rapid circulation becomes necessary and to maintain the circulation, it should be positive. This must be accomplished with some type of equipment that will create a pressure head to overcome the resistance offered in the tubes of the heating element.

There have been various types of pumping equipment designed to furnish this circulation and some of this equipment has given very good results but there is opportunity for further development.

Some of the types used are as enumerated:

1 Steam and electric power driven simplex, duplex and triplex surge pumps
2 Steam and electric power driven simplex and triplex piston pumps
3 Steam and electric power

driven simplex, duplex and triplex plunger pumps

4 Steam and electric power driven single and multiple stage centrifugal pumps

The various cracking units have different temperatures, suction and discharge conditions, but the one cardinal principle common to all is continuous operation. Interruptions can occur from two general causes and these apply to all types—

1 Failure of power

2 Failure of fluid end

IT WILL be noted that all types of pumps are driven with steam or electric power. A selection of the character of drive depends on the installation. Steam-driven pumps are generally recognized for their dependability and electric-driven pumps are recognized for their lower power operating costs. As both of these characteristics are desired, in some of the larger installations both steam and electric-driven pumps are installed, the steam-driven being held as a standby or reserve. As continuity of service must be had, the possibility of lightning interrupting the electric service must not be overlooked and if outside electric power is used, the possible causes of shutdown are increased.

Under such conditions, steam standbys should by all means be used.

The selection of the type of fluid ends calls for the consideration of more factors and it is difficult from past experience of any one type to say which is the best as each has its merits and selection can only be made after giving consideration to all the factors of design and also to the service requirements of the particular cracking unit.

The surge fluid end is built around the principle that the valves and valve chambers are removed a sufficient distance from the piston and cylinder bore to permit the cooling of the oil in the surge lines, this eliminating the necessity of the piston rings and liner working in the maximum temperature of oil.

The cooling of the oil in the surge lines has been accomplished in some cases by surrounding the surge line with a trough for water. In other installations the surge lines were of sufficient length to permit air cooling. Neither of these methods has been entirely satisfactory. In some of the installations being made today, it is the practice of one manufacturer of the surge type of pump to drill small holes for pipe connections in the piston cylinders, at a point beyond the extreme travel of the piston.

Through these openings small quantities of oil at normal temperature are fed. This oil can only travel in one direction, that is, toward the valve chambers. With this steady flow of oil in this direction, it might be said that an oil insulating medium is maintained between the piston and the valves.

THIS method of operation has improved the performance of the surge type pump materially. When the surge lines were cooled by water, or air cooled, the temperature would work back to the pump chamber, and due to increased temperatures and the resultant formation of gas pockets, the slip was increased and in many installations was as much as 50 per cent.

The piston type of fluid end is not different in fundamental design from the usual piston type pumps, except provision is made for packing the piston rod against the high temperatures. This is accomplished by the introduction of a long stuffing box, as long as or longer than the stroke of the pumps.

The design of this stuffing box is such that the part of the piston rod that comes in contact with the hot oil never comes in contact with the outside set of packing. In most of these stuffing boxes, cold oil is circulated between the outside and back packing, this cold oil acts as a cooling medium and reduces the temperature of the piston rod. It is possible with such a stuffing box to keep the piston rod that comes in contact with the outside packing at a temperature that will permit an operator to allow the rod to pass through the fingers when the pump is in operation.

In the piston type pump, it is necessary to select proper materials for the pump liner, piston rings, valves, valve seats and piston rods. This is very essential as these working parts come in direct contact with the hot oil. Progress has been made along these lines and it is surprising the service that pump parts will give under these severe conditions.

The plunger type of pump is quite similar to the piston type except for the elimination of liners and piston rings by use of the plunger. The packing of the plunger is accomplished in the same manner as the packing of the piston rod that is, with long stuffing box. The larger diameter of the plunger, however, makes it more difficult to pack. This fact suggests the selection of a plunger pump only when the pressures are very high. Under the high pressure, the leakage past the rings in a piston pump would cut the rings as well as the liner, increasing the slippage and reducing the volumetric efficiency of the pump, as well as increasing very materially the cost of repairs.

The success of centrifugal pump for handling hot oil has been a surprise to those who have strongly advocated the positive displacement pump. There are many of this type of pumps today at temperatures up to 850 degrees Fahr. and pressures up to 300 pounds per square inch. There are several features of this type that are likely to give trouble. First, on account of the high temperatures, and the behavior of metals at these temperatures it is necessary to make a vertical pump.

This introduces step bearing in both the pump and the prime mover. Every operating man is familiar with grief that can be had with this type of bearing. Second, the impellers of the pump are of the closed type with the resulting small passages that can fill up with carbon if by some chance the operation of the still gets away from the operator. When this happens the entire rotor must be taken out and cleaned.

Regardless of these features, however, many of the pumps are running every day. The user when contemplating the purchase of pumps for handling hot oils, should go very carefully into the different types of pumps, making his selection as to type and then leave the details of design to the manufacturers of the type of pump selected. Experience in this field of service is very valuable and not to take advantage of it would be courting trouble. While the ultimate has not been reached on this equipment which is the heart of the system, the results obtained by all types has been gratifying.

American Can Sues on Patent

LOS ANGELES, Aug. 26.—A patent suit has been filed in the federal court for southern California by the American Can Co. and E. W. Dunn against Riverside Sheet Metal Works of Riverside, Cal., seeking an injunction, an accounting and damages, charging infringement of patent No. 1,270,712, issued to E. W. Dunn June 25, 1918. In the complaint it is stated that Mr. Dunn on June 25, 1925, gave American Can Co. exclusive license to manufacture and sell orchard heaters under this patent.

The Lincoln Electric Co., Cleveland, O., has placed on the market a new carbon arc automatic welding machine designed for welding bottom seams on cylindrical tanks. It is standardized for tanks up to six feet in diameter and eight feet high but with special equipment it can handle all sizes. The edge weld on the bottom of some types of range boilers may be welded at the rate of 150 feet per hour, the company claims.

Value of Paint and Other Protective Coatings to the Oil Industry

By A. R. Moir

PAINT and protective coatings of a similar nature play an important part in our economic growth and welfare. It has been said that there is no better way to judge the prosperity and civilization of people than by the manner and degree in which they use paints. The savage tribes use paints only for decorative purposes, often in an effort to produce frightening or hideous effects rather than to beautify, as is shown by native warriors painting their bodies and faces in fantastic colors in an effort to frighten their opponents. In a similar way totem poles and other semi-religious objects are painted in colors designed to attract the good spirits and to frighten away the bad spirits.

Illiterate people of low civilization often use no paint at all on their buildings or other properties, because they do not understand its value either from a decoratitve or protective standpoint. Educated people more readily appreciate the necessity of paint for its aesthetic or psychological effect, but only those who have made a study of the subject realize the enormous value of paint and protective coatings as a preservative agent for protecting the investment and increasing the sale of their manufactured products.

Structural materials decay rapidly. Sun, wind, rain, heat, cold and other agencies of nature are constantly attacking all materials in an effort to disintegrate them. Many structural products show the initial stages of decay within a few hours or days after being exposed to weather conditions and the most durable materials soon take on a gloomy appearance that is very objectionable for several reasons. While paint and other protective coatings are also attacked by these destructive agencies of nature they act as guards of honor or buffers for the more valuable structures on which they are used, constantly fighting to protect the coated surfaces from the ravages of time. As long as the paint film remains intact it fights a good fight and successfully excludes the damaging agents. Fortunately, the protective film can be easily renewed from time to time and if so renewed at frequent intervals will preserve the structural material in its original state of soundness almost indefinitely.

Adequate surface protection through paint or varnish application is as important as sound engineering practice and design, for no matter how good the original materials, design or structure the destructive agencies of nature will soon win the fight against unprotected surfaces, destroying the value of millions of dollars worth of equipment and rendering worthless all the inventive and engineering genius expended in designing and building the equipment. Instead of being expensive to paint equipment and property frequently it is costly not to do so. A few pennies per square foot will pay for a coat of paint but the decay loss on unpainted surfaces may be several dollars per square foot of surface within a comparatively short time.

A. R. MOIR

Mr. Moir has been associated with The Glidden Co. for several years, devoting all his attention to painting problems of the oil industry. Born in England, he was educated in Australia and spent four years in South America. Since 1919 he has been a "sojourner" and is now a citizen of the United States. He has traveled over the Mid-Continent, Mexico and South American countries, as he says, "learning, applying and helping those in the oil industry in their problems for the conservation of property by the intelligent use of paint." He served four years in the world war, a private in 1914 and a major the last eight months of the war. Wounded in 1915 and in 1917 and decorated with the British military cross and by the French with the Legion of Honour and the Croix de Guerre.

OF ALMOST equal importance to the protective value of paint is the merchandising value of color, especially to large organizations whose customers are gathered from a large geographical territory. The consuming trade unquestionably gravitates toward those companies who keep their service stations, delivery trucks, tank cars, storage tanks, refineries, tank farms and other equipment well pointed. This is no doubt at least partially due to a subconscious reasoning that companies who so carefully take care of their property likewise manufacture their products in a uniform and careful manner that guarantees quality to the consumer.

If pleasing and distinctive colors are selected, each piece of equipment becomes the best kind of an advertisement. The consumer has the name of the oil company impressed on his mind each time he sees a tank car, truck, service station, or other equipment painted in a characteristic manner and automatically comes to associate the name of the company with the color combination. When driving in a strange section of the country the sight of this color combination over a service station readily distinguishes it as one dispensing the same good quality of merchandise he has been accustomed to at home.

The painting problems connected with the production, refining and distribution of petroleum are more numerous and diversified than those of almost any other industry. The conditions encountered in this industry are intensified and severe, necessitating the use of only the best products.

In the producing fields, tank farms and refineries, heat, fumes and chemicals particularly sulfur, add their destructive forces to others that are present in all climates. Pipe lines are attacked by the moisture and acid in the ground. Tank cars and distributing equipment are subjected to frequent and severe changes in temperature in going from one section of the country to another in addition to the solvent action of their contents on the finish.

Distributing stations and other property must be kept clean, neat and brightly painted in spite of the discoloring effect of grease and oil which is always present. Each of these sets of conditions calls for special treat-

ment to produce the best results. Each factor must be carefully studied and combated with paint materials designed particularly to resist its destructive action.

Painting, Storage and Field Tanks

THE proper painting of storage and field tanks is a very important matter since the paint must not only protect the metal of which the tank is constructed but also reflect the heat rays of the sun as much as possible to cut down evaporation losses. In making a selection of paint for this purpose many factors must be considered and each weighted against the other to determine what is best for each set of conditions.

Initial cost, protective value, durability, appearance and heat reflecting value must all be considered. If the protective value, durability and heat reflecting value of a particular paint is sufficiently greater than another it may be profitable to use it even though its initial cost may be higher than that of another paint, especially where rather volatile oils are stored.

On the other hand, if the oil in storage does not contain a large percentage of light oil the factor of heat reflection may be overbalanced by the items of cost, protection, durability and appearance.

It was formerly the custom to paint tank farm tanks with dark colored paints such as black, red or gray, on the theory that light colored paints do not have the wearing qualities of dark paints. This is erroneous as it has been proved that light paints can be made which are as durable or even more so than dark paints.

Several independent investigations have shown that the temperature and evaporation losses of oil in storage tanks is influenced largely by the color of the paint used on the tank and its ability to reflect the heat received from the sun by radiation. Radiant heat waves falling on a body are partially reflected, partially absorbed and partially transmitted through the body, if it is very thin or transparent. The nature of the color of a body has a marked influence on the proportion of the heat waves which are absorbed by that body.

H. A. Gardner, director of the Scientific Section of the Educational Bureau of the Paint Manufacturers' Association of the U. S. and the National Varnish Manufacturers' Association has made several laboratory tests to show the effect of color upon the absorption and reflection of radiant waves. One series of tests, described in circular 44, Paint Manufacturers' Association of the U. S., was made on small tanks of benzine painted in various gloss colors. When subjected to rays of a carbon arc light for a period of 15 minutes the temperature of the benzine rose as shown in Table 1.

Table 1

Effect of color of container on rise in temperature of benzine when subjected to rays from carbon arc for 15 minutes.

Color	Rise in temperature degrees F.
Tin plate	19.8
Aluminum paint	20.5
White paint	22.5
Light cream paint	23.0
Light pink paint	23.7
Light blue paint	24.3
Light gray paint	26.3
Light green paint	26.6
Red oxide iron paint	29.7
Dark Prussian blue paint	36.7
Dark chrome green paint	39.9
Black paint	54.0

Another test, described in Circular 131 Paint Manufacturers' Association of the U. S., was made on a series of small tanks of different colors filled two-thirds full with naphtha and exposed to the sun for two hours. Table 2 gives the result of this test.

Table 2

Comparative temperature and evaporation loss of naptha when exposed to the sun for two hours in small colored tanks two-thirds full.

Color of tank	Temperature of naptha degrees F.	Loss of naptha by volatilization per cent
Black	111	9
Bright red	109	8
Dark red	108	8
Dark green	108	8
Battleship gray	106	6
Tan	104	5
Red primer—white top coat	102	5
Cream	102	5
Pale blue	102	5
White	100	4

A practical test of the efficiency of various colors of paint in reflecting radiant heat has been made by the Bureau of Mines in co-operation with the State of Oklahoma and the results are given in Report Serial No. 2677 of the Bureau of Mines. This test was conducted on four 55,000-barrel storage tanks located under the same conditions on a tank farm and painted with black, red, gray, and aluminum paint of the type often used in the oil industry. Crude oil pumped directly from vapor-tight lease stock tanks, having a gasoline and naphtha content of approximately 29 per cent, a kerosene content of approximately 11 per cent and a gravity of 37.4 degrees A. P. I. was used to fill each tank within approximately 2,000 barrels of its capacity. The test lasted over an entire year, starting in January, 1924 and ending in January, 1925. The tanks were gauged monthly and samples of the oil were taken at similar intervals to determine how much and what types of distillates were lost by evaporation. Readings were also taken of the temperature of the oil and the vapor temperatures in each tank. Table 3 below gives a summary of the results of this test.

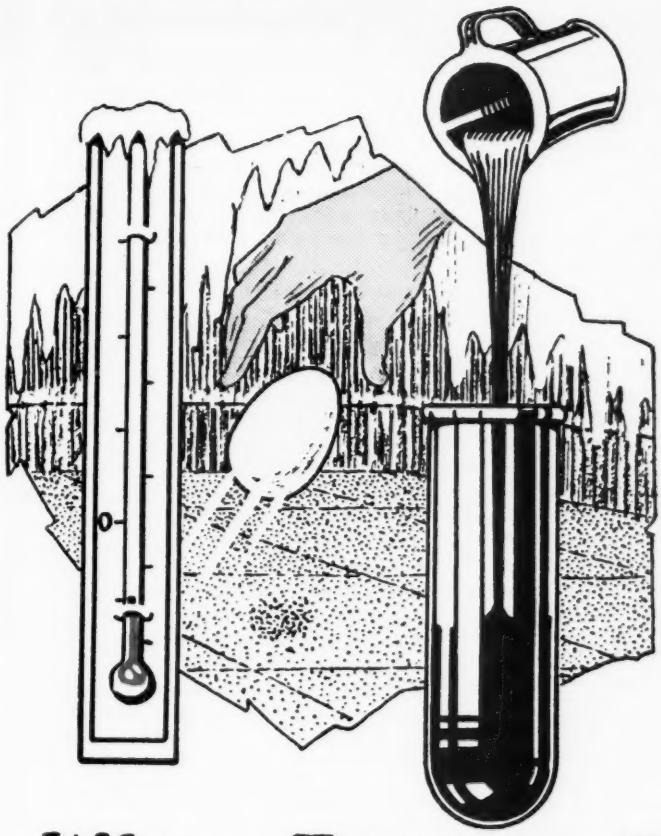
THESE three experiments plainly show that light colored paints retard the absorption of heat from outside sources and reduce the loss of volatile materials by evaporation. Unfortunately, white paint was not included in the Bureau of Mines test, as all available data indicates that aluminum paint and white paint are about equal in their power to reflect radiant heat. Certainly the saving of about 200 barrels of very high quality oil per year per 55,000-barrel tank would indicate that it is profitable to paint field and storage tanks once a year with aluminum or some other light colored paint.

It is a peculiar fact that it is the color of the outside or last coat of paint which determines the amount of heat absorbed by the contents of the tank. White paint, aluminum paint or a light colored paint can be applied over dark paints with approximately the same results as though the lighter paints had been used for all coats. Conversely it is necessary to keep the surface coat of paint light in color to maintain its efficiency. If dust, dirt, oil or other materials are allowed to collect on the surface in appreciable quantities the savings in evaporation losses will be greatly reduced. For this reason it is advisable to repaint with at least one coat of light colored paint each spring.

Regardless of whether aluminum or other light colored paints are used, the method of painting new tanks should be the same. A gray or red paint primer containing neutral or basic pigments ground in a suitable liquid to give toughness and adhesion, should be applied to the bare steel

Evaporation Losses From 55,000-Barrel Oil Tank During One Year

Color of tank	Initial Gage Barrels	Evaporation Loss In One Year Barrels	Evaporation Loss In One Year Per Cent	Loss In Gravity In One Year Degrees A. P. I.
Black	52058	649	1.24	0.6
Red	53294	609	1.14	0.5
Gray	53192	547	.99	0.3
Aluminum	53418	447	.83	0.2



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DEPT. 6
North Tonawanda, New York

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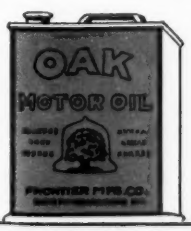

OAK MOTOR OIL

after it has been cleaned of oil, grease, rust or other foreign matter.

The necessity of using a rust-inhibitive priming coat containing neutral or basic pigments is explained more fully a little later in this article under the heading of Iron and Steel Buildings. It is of especial importance to use a good primer of the right construction on steel storage tanks because of the high sulfur content of some oils. For this reason the inside of the top of all tanks should be coated as well as the outside to prevent sulfur-containing vapors from quickly rusting out these parts of the tanks.

When the coat is dry one or two coats of light colored paint which has been especially prepared for tank service, or a like number of coats of aluminum paint, should be applied.

Where aluminum paint is used, the vehicle should consist of special bronzing liquids made by reputable varnish manufacturers, spar varnish thinned slightly with naphtha, boiled linseed oil or raw linseed oil. Of these the specially prepared bronzing liquids are most suitable in that they have been especially designed to float the aluminum powders and to dry more rapidly than any of the other vehicles mentioned above.

WHILE ready mixed aluminum paints are available the majority of the oil companies are mixing powder with the clear vehicle for each day's job. When aluminum paint stands ready mixed for a considerable period of time the flakes of powder often lose their polish and do not "leaf" or lap over each other properly. Moreover, the paint takes on a deader or slightly darker color and the thermal efficiency is reduced.

It is better to take the aluminum powder and mix it fresh daily at the rate of 1¼ to 2 pounds of powder to the gallon of vehicle. This is best accomplished by putting the weighed dry powder in a suitable can or pail and slowly pouring a measured volume of the vehicle over it, stirring all the while, with a wooden paddle. By this means the powder is quickly dispersed in the liquid whereas if the dry powder were dumped into the liquid or all of the liquid poured at once into the powder more time is required to stir the mixture free of lumps. Only enough paint should be mixed for one day's use at a time and it should be stirred from time to time as it is being used.

The aluminum paint as well as regular types of light colored oil paints can be applied by brushing or spraying with compressed air. The spray method of application is faster and will give better results than the hand brush method.

Painting Hot Surfaces

Hot surfaces in refineries and elsewhere should be painted whenever possible to protect the metal from rusting, to cut down the losses by radiation and to improve the appearance of the equipment. The successful painting of such surfaces calls for the use of special paints. These paints should be applied while the surface is cold and allowed to dry thoroughly before the surface is heated again. Failure to observe this precaution is likely to result in blisters or bubbles forming in the film which will later flake off and leave bare spots.

LIGHT colored paints of the ordinary type cannot be used for this purpose, since practically all white and colored pigments are darkened upon exposure to temperatures in excess of about 200 degrees Fahr. Darker colored paints made over a formula containing a liberal proportion of linseed and Menhaden oil can be used where the temperature does not exceed about 400 degrees Fahr. Above this temperature there are two classes of paint that can be used. The first consists of black asphaltum type paint which may or may not contain a special heat resisting black pigment. The other is made by mixing aluminum bronze powder with a special heat resisting bronzing liquid which has been developed by a very few of the leading paint and varnish manufacturers. Either of these paints will resist temperatures up to about 900 degrees Fahr.

The aluminum type of paint is preferable in most cases to the black paint because the aluminum paint holds the heat in a furnace, still or steam pipe in much the same manner as it holds the heat out of storage tanks which are exposed to the sun, due to its lower rate of absorption of heat waves. Furnaces, stills and other heating equipment will maintain the same temperature with less fuel consumption or a hotter temperature with the same fuel consumption when they are painted on the outside with specially prepared aluminum paint. This not only results in an economy of fuel but also causes the working conditions in boiler rooms, still houses, etc., to be more comfortable.

While these hot surface paints lose much of their water resisting and weather-proof qualities after being heated to high temperatures there is a close bond of the paint to the steel surface, especially if the surface was thoroughly clean and slightly rough at the time of painting. These paints are also resistant to hydrogen sulfide or other sulfur containing gases.

Painting Stations and Buildings

STATIONS and buildings connected with the oil producing, refining and distributing industry should be kept well painted not only to prevent rapid deterioration but also as an aid to merchandizing plans. Each type of structure should be painted with materials constructed particularly for that use. Concrete and brick surfaces require different treatment from either wooden or metal surfaces for best results. It is advisable for each company to select individual and pleasing color standards for its buildings and stations for economy and merchandising efficiency.

Wooden Buildings

NEW wooden buildings should be treated in much the same manner as other wooden structures such as residences. Knots and sappy places should be shellacked to hold back the resin and then the entire structure primed with a long oil paint to which a pint of raw linseed oil and perhaps a little turpentine have been added. This coat should be allowed at least three days to dry and then be followed with two or more coats of full bodied paint with plenty of time between coats for thorough drying.

Old structures should receive a coat of long oil paint about once a year to keep them in a good state of preservation and appearance.

Iron and Steel Buildings

IRON and steel surfaces which are exposed to the weather must be carefully protected with the right type of paint to prevent rapid and severe losses. The question of the causes of rusting or corrosion of steel is briefly discussed in a book by M. J. Pearce entitled "Modern Automobile Painting" which has just been published, as follows:

"It is a fact that the decay of iron and steel, if natural agencies are allowed to act on them without interference, is far more rapid than that of wood and other building materials which are universally protected by frequent applications of paint. Rusting or corrosion of iron and steel can be prevented quite easily, however, by the simple expedient of protecting it from moisture. When so protected it is one of the most durable substances known and an automobile body constructed of steel will last much longer than the mechanical parts.

"This question of the rusting of iron and steel is so important from an economical standpoint as to warrant the use of some space to discuss it in more detail. Three theories have been advanced to explain corrosion, namely, the carbonic acid theory, the hydrogen peroxide theory, and the electrolytic theory. To completely explain these three theories, giving the arguments for and against each, would require much more space than is available in this book; but it is now an accepted fact, that corrosion is dependent largely upon auto-electrolysis, that is, electrolysis due to currents set up between different parts of the material itself.

"In other words, it is not necessary

that an external source of electricity be provided before electrolysis can take place. The small quantities of impurities which are always present in steel serve to form numerous small batteries within the steel structure itself which in the presence of an electrolyte or a liquid medium which serves as a conductor, generate small electric currents that start the corrosive action. The moisture which is ordinarily present in the atmosphere is sufficient to close the circuit and start corrosion.

"Once the circuit has been closed and the small currents start flowing, the oxygen of the air attacks the iron, forming the basic oxide commonly called rust. All investigators are agreed, however, that iron cannot rust in air or oxygen unless water is present; and, on the other hand, it cannot rust in water unless oxygen is present. Unless moisture is present the iron cannot go into solution, and unless oxygen is present the ferrous iron cannot be oxidized nor can the hydrogen enter in combination with it to regenerate water. Both oxygen and moisture are necessary for rusting to start, and these are always present in the air.

"If rust once starts to form it will continue to grow by making use of the oxygen and moisture over and over again, even if a good protective coating has been applied over it. It it very important, therefore, to have the metal absolutely clean and free from rust before starting to paint.

"The problem of protecting iron and steel, then, resolves itself into one of applying a coating which will, as nearly as possible, prevent moisture and oxygen from reaching the over again, even if a good protective paint coating prevents corrosion just so long as it remains a dense, perfect coating that excludes all moisture. As soon as it begins to break down and deteriorate, moisture is allowed to penetrate and starts the formation of rust which spreads under the coating, expanding and pushing off the latter."

A VERY complete bulletin has been prepared by R. Van A. Mills and issued by the Bureau of Mines as Bulletin 233, "Protection of Oil and Gas Field Equipment against Corrosion". While this bulletin deals primarily in oil and gas wells it describes in detail the causes of corrosion of all types of equipment and suggests methods of reducing losses by corrosion in surface equipment as well as in casings.

The nature of the pigments contained in the priming coat which is applied to iron and steel has a decided effect upon the rate and character of rusting. Tests made by the American Society for Testing Materials, have plainly shown that pigments of a basic nature and those which contain soluble chromates tend to prevent rusting. Pigments of a slightly acid nature, however, are rust-inciting or rust-stimulating.

Red lead has long been used as a priming material for iron and steel and it gives quite satisfactory results. It has the disadvantage of caking hard in the package, however, and also it is not as rust inhibitive as some of the specially prepared paints, which incidentally also have a more pleasing and more easily covered color, and are less expensive.

The results of a five year exposure test of steel panels made by the American Society for Testing Materials at Atlantic City are given in circular No. 35 of the Paint Manufacturers' Association of the U. S. and are reproduced in Table 4.

Comparative Rating of Pigments Present in the Ten Best Paints in Atlantic City Tests

Pigment	Date of Inspection 1910	1911	1912	1913	1914
Basic chromate of lead	9.1	10.0	9.9	9.8	7.5
Sublimed blue lead	9.6	8.8	9.0	7.2	6.0
Carbon black and barytes	....	....	....	6.8	5.0
Chrome green	9.8	9.8	8.6	7.6	5.0
Willow Charcoal	....	8.8	8.6	7.9	4.5
Red Lead	....	....	8.1	....	4.0
Natural graphite, containing clay, etc.	....	....	....	....	4.0
Zinc Chromate	9.4	9.5	8.8	8.0	4.0
Zinc-and-lead Chromate	9.5	9.7	9.2	8.3	4.0
Magnetic black oxide	9.5	9.5	8.6	7.8	4.0
Zinc-and-barium Chromate	9.7	9.5	8.5	7.8	....
Sublimed white lead	9.5	9.0	8.1	....	....
Bright red oxide	9.3	....	....	....	....
Prussian blue (water stim.)	9.2	....	....	6.7	....
Prussian blue (water inhib.)	....	8.5	....	....	....

In this same series of tests it was proved that such pigments as orange mineral, artificial graphite, white lead, lithopone, carbon black, lamp black, yellow ochre, coal tar and similar materials having a slightly acid nature, promoted rusting.

An extensive investigation of steel paints was made by J. S. Coye and the results are published in Bulletin 54, Good Roads Section, Engineering Experiment Station, Iowa State College, Ames, Iowa. The following quotation is a portion of the conclusions drawn from this test and published in the above mentioned bulletin:

"The tests have demonstrated that:

"1. Too much emphasis cannot be placed upon the fact that gypsum and whiting are harmful when present to a much greater extent than 5 per cent of the pigment. In every case where these materials have been present to a considerable extent the paint has failed to protect and rusting usually begins underneath the film.

"2. It is not safe to use carbon and graphite paints for the first coat on steel.

"3. Coal tar paints are worthless for structural steel exposed to the atmosphere under ordinary conditions.

"4. Asphaltic base paints as a class should not be specified as a general structural steel coating although those which have withstood a good service test may be specified individually.

"5. (a) Red lead, sublimed blue lead, sublimed lead sulfate and zinc and lead whites are very effective for first coats and produce good surfaces for repainting.

"(b) Frequent repainting is necessary when they are used for field coats.

"6. Red lead, sublimed blue lead, sublimed lead sulfate, zinc lead white, white lead or leaded zinc pigments are always safe pigments for a shop coat paint.

"7. (a) Pure iron oxide paints may be safely used for a shop coat but should preferably be mixed with about 10 per cent zinc or lead chromate.

"(b) Iron oxide paints containing gypsum or whiting in any considerable extent are not serviceable for either shop or field coats on structural steel.

"8. There are certain carbon paints on the market which produce such a strong, elastic, and impermeable film that they may be used for both shop or field coats for structural steel, providing the painting is done in a thoroughly good, workmanlike manner.

"9. Graphite or carbon paints, the pigment of which contains 20 per cent of basic lead chromate, zinc chromate, lead oxide or sublimed lead sulfate, are good shop coat paints, and also prove very serviceable for field coats."

COMPETENT paint manufacturers have heeded the results of these tests and now offer metal protective paints in a wide range of color which d›

not stimulate rusting. Provided a rust-inhibitive paint is used next to the metal as a primer any good quality of long-oil house paint ordinarily used on wood can be used safely for finishing coats.

Before applying paint to any metal surface care should be taken to remove all rust, scale, grease and dirt. Failure to do so will cause unsatisfactory results either through the growth of rust under the paint film or the peeling off of the paint due to lack of adhesion. Clean, dry, rust-free surfaces are important for lasting results.

Galvanized Iron Buildings

MORE or less trouble generally is experienced in making paint materials adhere to zinc or galvanized iron surfaces. These surfaces when new always have a greasy feel to them, even though there may be no grease actually present. This greasy feel may be removed to a certain extent by washing the work with naphtha, but this treatment is often not severe enough to put the surface into proper condition for the paint coats to stick as tightly as they should.

It is claimed by some who have investigated the question thoroughly that this property of zinc or galvanized iron not to hold paint is due to the zinc combining with the oil of the paint film to produce a soap. This soap layer, it is claimed, forms between the metal surface and the paint and thus prevents the paint from sticking to the surface, so that upon subsequent contraction and expansion of the metal the paint flakes off.

Regardless of whether this or some other condition is the true cause of this non-sticking condition, it is a well known fact that zinc or galvanized iron which has been exposed to the weather for some time holds paint much better than fresh surfaces. This is probably due to the zinc surface being attacked by oxygen and other chemicals which are present in the air and in rain water in various amounts to form zinc salts which have a rougher surface and do not react on the paint film in the same manner that the zinc does.

This weathering of zinc and galvanized iron can be artificially produced by the use of various chemical washes which remove any grease that may be present and in some instances form a coating of zinc chloride or other zinc salts to which paint adheres more readily than to plain zinc surfaces.

One of the best chemical washes for this purpose is made as follows: Dissolve 12 ounces of copper chloride, 12 ounces of copper nitrate and 12 ounces of sal ammoniac in 4½ gallons of water, then add 12 ounces (by weight) of hydrochloric (muriatic) acid. This solution should be applied to the metal, allowed to dry until the next day and the bloom brushed off, after which the paint should be applied as quickly as possible.

Another wash which has been used quite extensively is made by mixing one part (by volume) of commercial hydrochloric (muriatic) acid with four parts of water. This solution should not be allowed to remain on the surface very long, especially in the case of galvanized metal for fear of dissolving most of the zinc. As soon as the surface is dry the paint may be applied.

Yet another zinc wash is an ammonia solution which should be applied to the surface as strong as the workmen can stand it. This solution, however, has the drawback of a rather disagreeable odor and does not give as good results as some of the others.

Still another method of treating galvanized iron or zinc is to first wash the surface with naphtha or benzine and then coat the work with a solution of copper acetate made by dissolving six ounces of copper acetate to a gallon of water. After this solution is dry the painting operation may proceed in the usual way.

Many people find a weak solution of acetic acid to be satisfactory as a wash for galvanized iron. Strong vinegar will give almost the same results. The important thing is to use something that will cut the grease and give a slightly etched surface.

It is to be understood, of course, that an earthen or glass vessel should be used for holding any of these solutions. Care must be taken also to protect the hands of the workmen, especially where a solution containing acid is used. This can be done by thoroughly saturating the hands with linseed oil and wiping off the excess oil with burlap or an old cloth before beginning the work.

AS A general rule, the best method of applying any of the solutions is to wash the surface with a cloth or piece of burlap wet in the solution; or a soft, flat brush may be used if desired.

Another important point to bear in mind is that the metal should be painted soon after the galvanized iron wash has done its work and the moisture has evaporated from the metal. If too much time elapses between the treatment and the first coat of paint, much of the good effect derived from the wash will be lost.

Where it is not desired to use one of these chemical washes and if the equipment is available, the use of a sand blast is recommended. This roughens the metal and gives the primer the safe foothold that is desired. Where the sand blast is used the work should be coated as quickly as possible to prevent the formation of rust, should the thin coat of zinc on the galvanized metal be broken by the blast of sand.

Several years ago, after considerable experimental work, one of the large paint companies developed what is probably the best galvanized iron primer on the market today. This is the familiar red metal primer which derives its good sticking qualities from a special combination of liquids and mineral pigments which have a great affinity for zinc, aluminum and similar metals as well as for iron and steel. It can be applied by spraying or brushing after being reduced at the rate of four or five parts of red metal primer to one part of turpentine, or turpentine substitute, and will dry to recoat in 24 hours. It is very tough and durable so that it will withstand exposure for months without any signs of disintegration. It is safer to treat zinc surfaces before applying red metal primer but it is not absolutely necessary for if the metal, whether zinc, aluminum or steel, is free from grease, rust and dirt, red metal primer will be found to stick to it quite well.

Brick, Stucco and Concrete Buildings

ALTHOUGH brick, stucco and concrete buildings are strong and durable these assets are often counteracted by the unpleasing appearance, especially during wet weather when these materials absorb large quantities of water. This increased moisture may penetrate to the inside of the building and push off the decorative finishes on the plaster walls or may leave permanent, unsightly stains on the exterior surfaces. For these reasons it is sometimes advisable to paint such buildings, especially when a continuous pleasing appearance is desirable as in the case of service stations.

If the brick, stucco or concrete is well aged and thoroughly dry no special preparation need be made of the surface, although better adhesion can sometimes be obtained if the surface is first primed and waterproofed with a special type of colorless waterproofing compound made by a few of the larger paint companies. As a rule, good results can be obtained by brushing or spraying the special colored paints made for stucco directly on clean, dry surfaces. The customary type of house paint also gives fair results on exterior work. Flat wall oil paints should be used for interior surfaces.

If the surface is "green" or wet and contains any substantial amount of free lime, it should be treated with a neutralizing liquid containing two or three pounds of zinc sulfate crystals dissolved in each gallon of water.

before any coats of paint are applied. This solution can be applied by brushing or spraying and should be used on "green plaster" as well as on outside concrete or stucco surfaces before painting. After the solution has neutralized the free lime and has dried for 24 hours, the paint may be applied in the customary manner by brushing or spraying.

Cement floors may be hardened and rendered more impervious to the absorption of oils and greases by treating them with a water solution of magnesium fluosilicate or of sodium silicate. When so treated they may be painted over in the usual manner, but, it is not absolutely necessary that they should be so treated before painting.

Prepared cement floor paints and brushing lacquers are the best materials with which to paint concrete floors. The use of these coatings greatly improves the appearance of floors, prevents the formation of dust, makes for easier cleaning and prolongs the life of the floors. Usually at least two coats are applied on new floors and old floors are renewed with one coat of paint or lacquer as soon as the finish begins to show signs of wear. When using the prepared cement floor paints each coat should be allowed to dry at least 24 hours. Brushing lacquer dries much quicker and a coat can be applied within an hour after a previous coat.

Painting Tank Cars and Miscellaneous Equipment

TANK cars are really field or storage tanks on wheels and the same general suggestions as given in that section of this article apply to painting them. In the past it has been almost the universal system to paint tank cars black or in other dark colors. To reduce the amount of evaporation caused by absorption of heat from the sun and to increase the advertising value to which tank cars can be put as they are pulled through all parts of the country it would seem worth while to consider the advisability of painting the tank car with lighter colors or with aluminum paint.

The bare metal of tank cars should be primed with a rust-inhibitive primer of a sufficiently elastic nature to withstand the vibration and expansion and contraction due to changes in weather conditions while in transit. When this primer coat is dry the tank should be finished with one or more coats of tank car enamel which has been formulated to resist the solvent action of gasoline or other oils spilled on the finish while the tank is being filled or emptied. Of course, these enamels should be hard enough to resist the abrasion of flying cinders, hob-nailed shoes, etc. The underframe should be finished with a paint made

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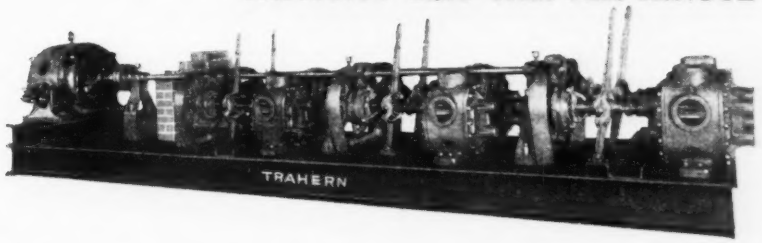

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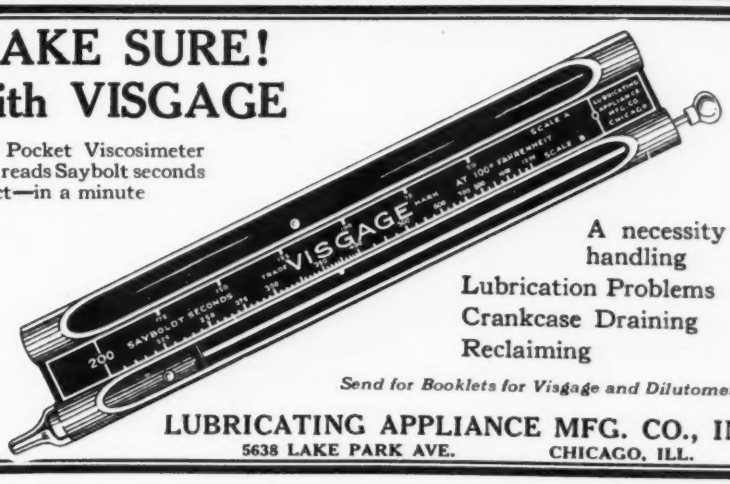

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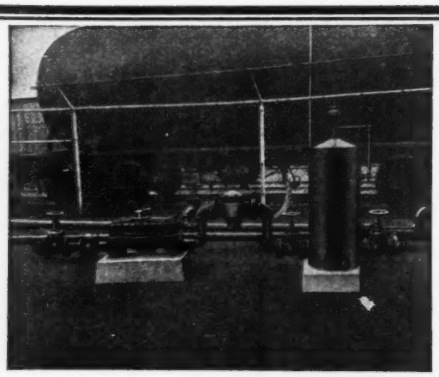

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Great success has been obtained. The cars are acknowledged to be cleaner and brighter after two years' continuous service than those unvarnished, and a considerable labor and material cost saved, as less frequent repaint jobs are necessary under the system.

Tank Delivery Trucks

Tank trucks should be finished in an attractive color combination in conformity with the colors used for painting the service stations. Special prepared finishing materials should be used for this purpose. A rust-inhibitive primer should be used next to the metal and this coat followed by surfacer coats and colored enamel coats. Special prepared enamels which have extreme oil and gasoline resisting qualities are available and should be used for the finishing coats.

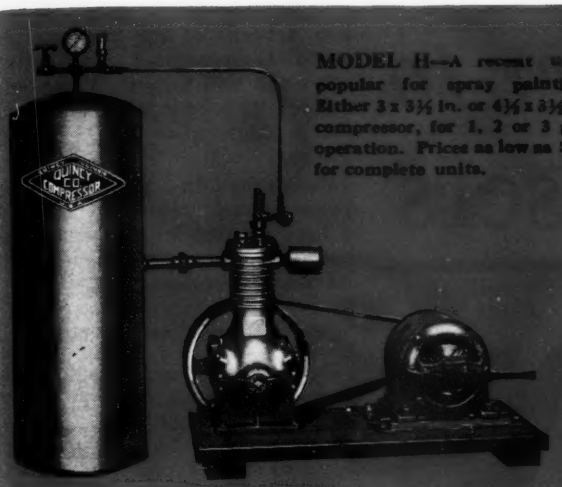
Nitro-cellulose lacquers have not proved very satisfactory for this work because of the fact that it is almost impossible to remove all traces of oil and grease from the surface when starting to repaint. Lacquer will not adhere to oily or greasy surfaces and soon chips and flakes off under such conditions. Proper types of oil enamels, on the other hand, will adhere well if the accumulation of grease on the old finish is not too great.

Once the surface has been brought up to a smooth condition repainting can be done by applying one or two coats of suitable enamel over the old finish. Where extra high luster or a deluxe type of finish is wanted, the last coat is sometimes a special clear varnish.

Pipe Lines, Pumps and Machinery

The pipe lines around refineries, storage tanks and service stations should be preserved by being painted with a standardized system of colors to readily identify the use to which each line is put. Yellow, green, buff, gray, bright red, white, brown, blue, black and other colors can be used to designate different oil water and gasoline lines and will thus readily prevent confusion and error in turning the wrong valve.

The service pumps at distributing stations should be painted with glossy, bright colors so they can easily be seen by customers. Some state regulations require all gasoline pumps to be painted red but in other states the pumps can be painted with a characteristic color which is used as a standard and corresponds with the



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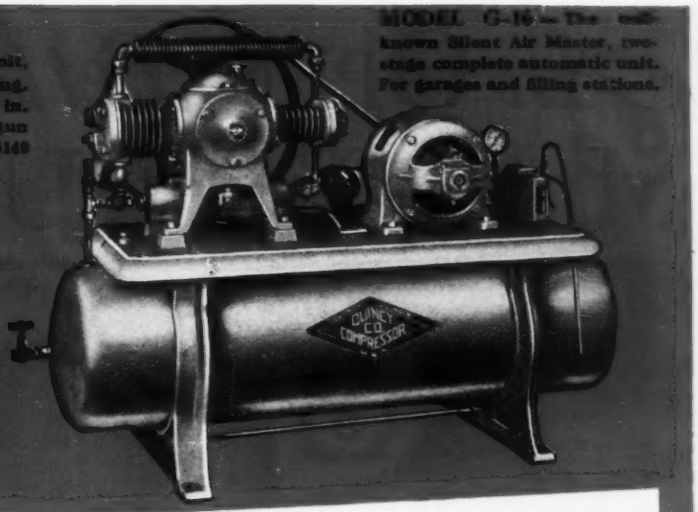

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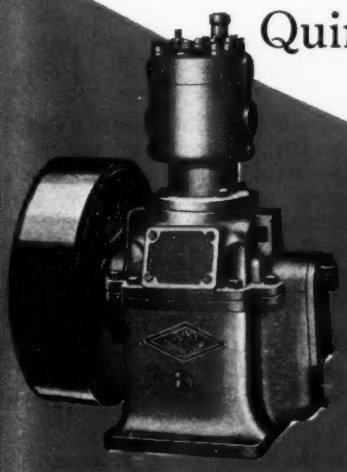

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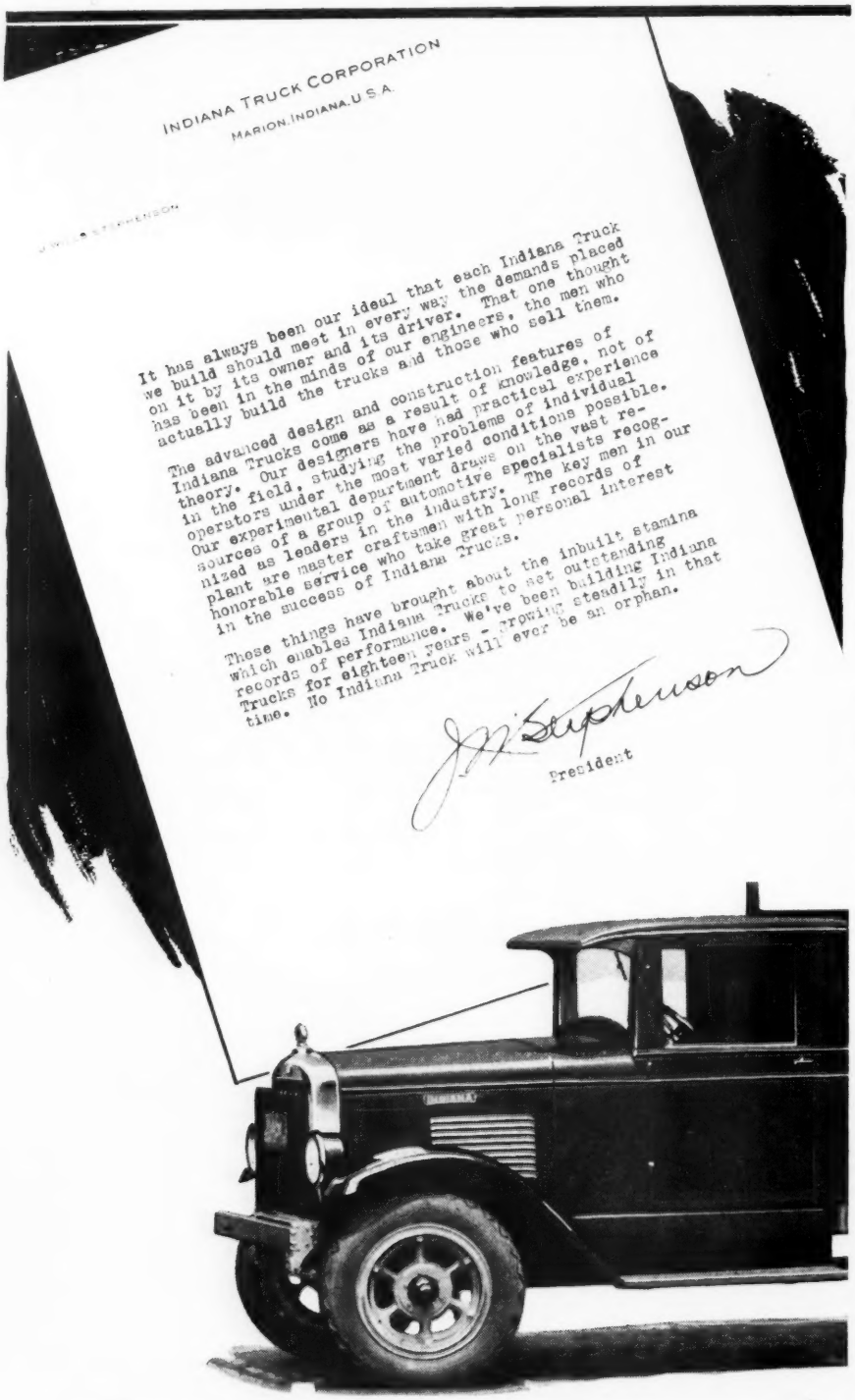
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color scheme of the station. Pumps should be repainted frequently and kept clean and bright. Pump enamels or specially prepared brushing lacquers with a high gloss can be used for this purpose.

Machinery in pumping stations, power houses, refineries, etc., should be kept painted with a good grade of machinery enamel so made as to resist oil, water and heat.

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Conclusion

Millions of dollars can be saved in the oil industry yearly by keeping all equipment and property adequately painted. Additional millions of dollars of trade can be attracted by selection individual pleasing color combinations and using these colors for painting all equipment viewed by the buying public. Since the labor cost of painting is always much heavier than the material cost it pays to use only the best quality of paints and finishing materials, and thus reduce the frequency of repainting. The larger paint companies will gladly help any oil company select color standards and suitable qualities of paint for their various equipment.

Semet-Solvay Engineering Corp., 40 Rector St., New York, has received the contract for the construction of a complete motor benzol plant for the Hamilton By-Product Coke Ovens, Ltd., Hamilton, Ont. The plant will handle 3,000 gallons of light oil daily. The benzol plant will cost $400,000. will be equipped with three light oil scrubbers, 13,000-gallon light oil storage tank, 7,000-gallon boiler still and two 16,000-gallon benzol storage tanks.

Crouse-Hinds Co., Syracuse, N. Y., has off the press two bulletins entitled "Greater Efficiency in Floodlighting" which describe and illustrate various types of floodlight projectors for large buildings and other large areas. Greater efficiency is obtained in the design of the reflector, the company states, due to the reflector intercepting and redirecting into the beam a greater proportion of lamp rays than has previously been obtained.

Methods of Fireproofing Steel In Refineries Analyzed

By E. R. Powell

Chief Engineer, Banner Rock Products Co.

NUMEROUS specifications have been proposed for fire-proofing the steel work which supports essential apparatus around refineries. Some of these specifications have been tested, but comparatively little fire-proofing material has been applied. There has been some lack of confidence (in many cases well-founded) on the part of refinery engineers in the methods which the various contractors have proposed.

The potential value of fire-proofing of this sort is admittedly great. It remains to place the subject on a rational basis so that protection can be relied on for a reasonable length of time.

The principal method which has been used in the past for this purpose has been application of insulating materials around the members. In addition, a refractory coating of some sort has been applied on the outside. If this material is applied to a uniform thickness around a structural channel, it will take the form shown in Figure 1. Sometimes the corners are made square for the sake of appearance or because the insulation is applied in block form. The effect of corners, however, is to increase the heat-absorbing surface of the material and decrease its ability to stand mechanical abuse.

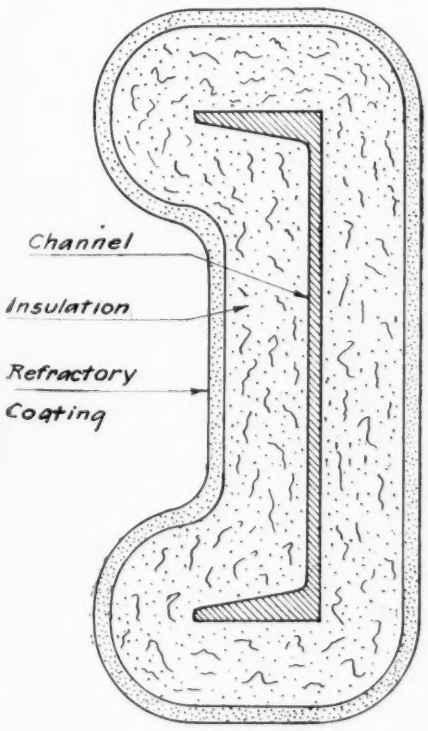

Fig. 1

Steel channel protected with insulation and refractory coating.

THE necessity of providing some better protection than that shown in Figure 1 may be seen from the following calculations: Assume the steel member to be a 6-inch channel, which weighs 6.7 pounds per foot, and that the fire reaches a temperature of 2500° F. Take an arbitrary limit of 900° F. for the allowable temperature of the steel.

Assume a 1¼-inch thickness of insulation having a conductivity of 0.7 B. t. u. per square foot per hour per degree Fahr. Then if the average conducting area of the insulation is 0.83 square feet per running foot, there will be approximately 0.40 B. t. u. transmitted per degree temperature difference.

If the average temperature difference is 2000°, there will be 800 B. t. u. transmitted per hour. This heat will go into 6.7 pounds of steel having a specific heat of 0.118, so that it will take only 0.79 B. t. u. to raise the steel 1 degree. It may be seen from this that it will take only approximately ¾-hour to raise the temperature of the steel from 70° to 900° F.

The calculations are rough, but they establish the correct order of magnitude and show that with insulation alone it is not feasible to protect steel for any great length of time. It will be noted that a good layer of relatively efficient insulation was assumed, and represents about the practical limit of this method of protection.

BUT while the entrance of a certain amount of heat cannot be prevented, it is possible to increase very greatly the amount of heat which can be transmitted without unduly raising the steel temperature. This can be done by the application of such a material as Banroc Fireproofing Specification, which consists of a heat-absorbing material, an insulating material and a refractory coating, as shown in Figure 2. The heat-absorbing material is a comparatively large weight of inexpensive material which has the property of requiring a large amount of heat to raise its temperature.

It will be noted in comparing Figures 1 and 2 that there is about the same amount of insulation in both cases. The labor on Figure 2 should also run about the same as for Figure

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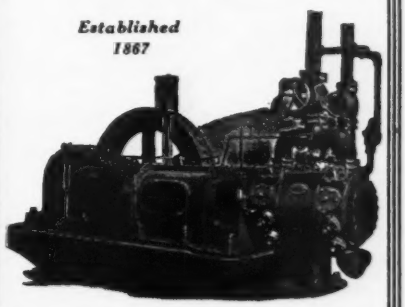

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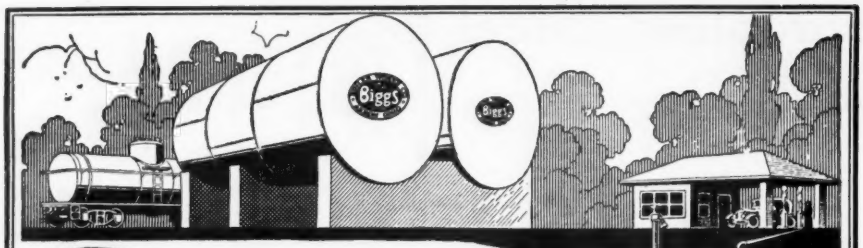

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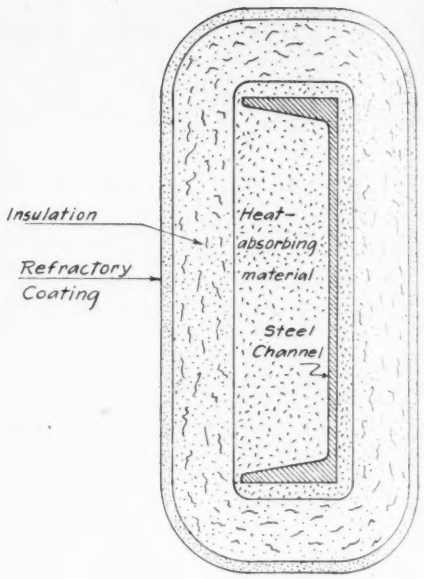

Fig. 2

Steel channel protected by insulation and refractory coating with heat absorbing material added

1 since a flat surface has been substituted for some of the curves. The reason for the heat-absorbing properties of this material lies in certain highly endo-thermal reactions which take place when it is heated.

The value of this material in extending the life of the fire-proofing may be readily seen from the following calculations: Assume that 7 pounds of this material are used per running foot and that it has a heat-absorbing capacity of 300 B. t. u. per pound below 900°. It will then require about 2750 B. t. u. total to raise the temperature of each foot of the steel to 900°. Thus by the addition of heat-absorbing material, the life of the specification has been extended from ¾-hour to 3½ hours.

Practical tests have been conducted to prove out this principle. Short samples of channel were suspended side by side in a furnace at about 2500° F. They were equal in weight and size. The fire-proofing material had the same outside dimensions, but the inner layer of insulation was omitted on the second sample, and fire-proofing material was substituted.

The heat-absorbing material being a little more dense, the second combination was a little heavier. With this arrangement, heat was conducted from the ends in a manner hard to calculate, but since the samples were treated identically in all other respects, the difference in life of the two was considered due to the fire-proofing material.

The second sample (fire-proofed as shown in Figure 2) required about 3½ times as long to reach a temperature dangerous to steel as the first sample.

Systematic Plan Is Needed for Proper Upkeep of Refinery

By D. F. Gerstenberger

D. F. GERSTENBERGER

Mr. Gerstenberger was born in Olean, N. Y., in 1895. Educated in schools of Cleveland, O., and Roselle, N. J. Took one term in chemical engineering at New York University and complete steam engineering course from the International Correspondence Schools. Started in oil industry in 1915 as fireman of crude stills at Standard of New Jersey Bayway refinery. In September, 1916, he was transferred to the first battery of Clark pressure stills. Later in the same year was promoted to assistant foreman of pressure stills and in 1917 was made foreman. In 1920 was sent to Charleston, S. C., refinery of the Standard of New Jersey as assistant general superintendent. Helped build and operate the plant. In 1922 he was transferred back to Bayway as night superintendent. In December, 1923, went to work for Louisiana Oil Refining Corp., as superintendent of cracking plant. In July, 1926, was made superintendent of the Shreveport refinery of the company.

WE HAVE previously taken up the maintenance of the cracking still (N.P.N. July 27, page 71) with a view to conveying the impression that this equipment should be inspected methodically and thoroughly to insure efficient and safe operation. We will deal in this article with suitable methods of handling refinery maintenance as a whole, and will endeavor to bring to the surface mechanical problems of especial interest that can have a bearing on the efficient operation of the plant as a whole.

In view of the fact that this article is to cover considerable territory, it must of necessity be somewhat general, touching only in detail on actual essentials.

Most of the larger refineries undoubtedly have systems in operation for the handling of refinery maintenance which are considered satisfactory. Many of the smaller plants, however, are not so fortunate. In many instances, it is felt that the plant is so small that a system for upkeep and repair is not an essential.

You would not consider operating your stills by a hit or miss method, and therefore, I would point out that system in the maintenance work, which must go hand in hand with the operation, should exist for economy, as well as efficient operation. One operation without system cannot dove-tail into another which lacks this essential.

How to Handle Repairs

LET us start with certain repairs and carry them through to completion in a systematic manner. The writer prefers concrete examples, for by such a method we may better understand the thought conveyed, and can try and fit it into our present methods, as our needs require. For this reason, we will have one of our crude stills develop a bad leak in the condenser worm. This must be repaired immediately. Also we will assume that a crude pump on this same battery of stills needs minor repair. Each point will be considered separately.

In each instance, a mechanical order request, or what we will hereafter term an M. O. request, is made out by the still foreman, to have this work done, and it is addressed to the refinery engineer, if one exists, or to the general mechanical foreman. The first would read, "Please make necessary repair to condenser worm, crude still No. 9. Charge to repairs, crude stills." The second, "Please repair crude charging pump No. 26 at convenience of stillman." Charge to repairs, crude stills.

For the sake of reference, and proper record, these forms are usually put up in small perforated booklet form, with card-board cover, of about 5 inches wide and about 4 to 5 inches long, and have every other page unperforated and of pink or yellow paper, which is retained as a duplicate in the book. Such requests should pass through the hands of the superintendent or assistant superintendent, for scrutiny with a view to economy as well as actual necessity of the repair.

IN THE case of the leak the work should be done at once, and of course the authority for emergency repair should rest in the hands of the department head. The M. O. request is issued as usual and marked "confirmation" to show that the work has already been started and that the regular channels have been by-passed.

The engineering office, or the office of the general mechanical foreman, as the case may be, assigns a number to each M. O. request and each number is represented by a mechanical order, which we will hereafter term M. O. The M. O. is the engineer's or mechanical foreman's written instruction to the mechanic to do the work. It is worded like the request, and is put up in practically the same form. The book copy is retained in the office for further use and for record.

We will assume that by the time the repair work on No. 9 crude still is about half completed, the pipe fitter has received M. O. No. 771 which covers the work. After the work is completed, and inspected by the department head, and mechanical foreman if desired, the pipe-fitter O. K.'s the M. O. and in due time it is returned to the office where it is filed as being completed.

A daily list of M. O.'s with their numbers, and a description of the work, is made out. One copy is forwarded to the superintendent, one to the accounting department, and a third is retained in the engineering office. As M. O.'s are returned as completed, they are posted as such on this daily list, and in this way it is possible to be sure that all work requested has been completed. The accounting office will make the proper entry on the books from this list of M. O.'s so that this work is charged against the repair of these stills for the month.

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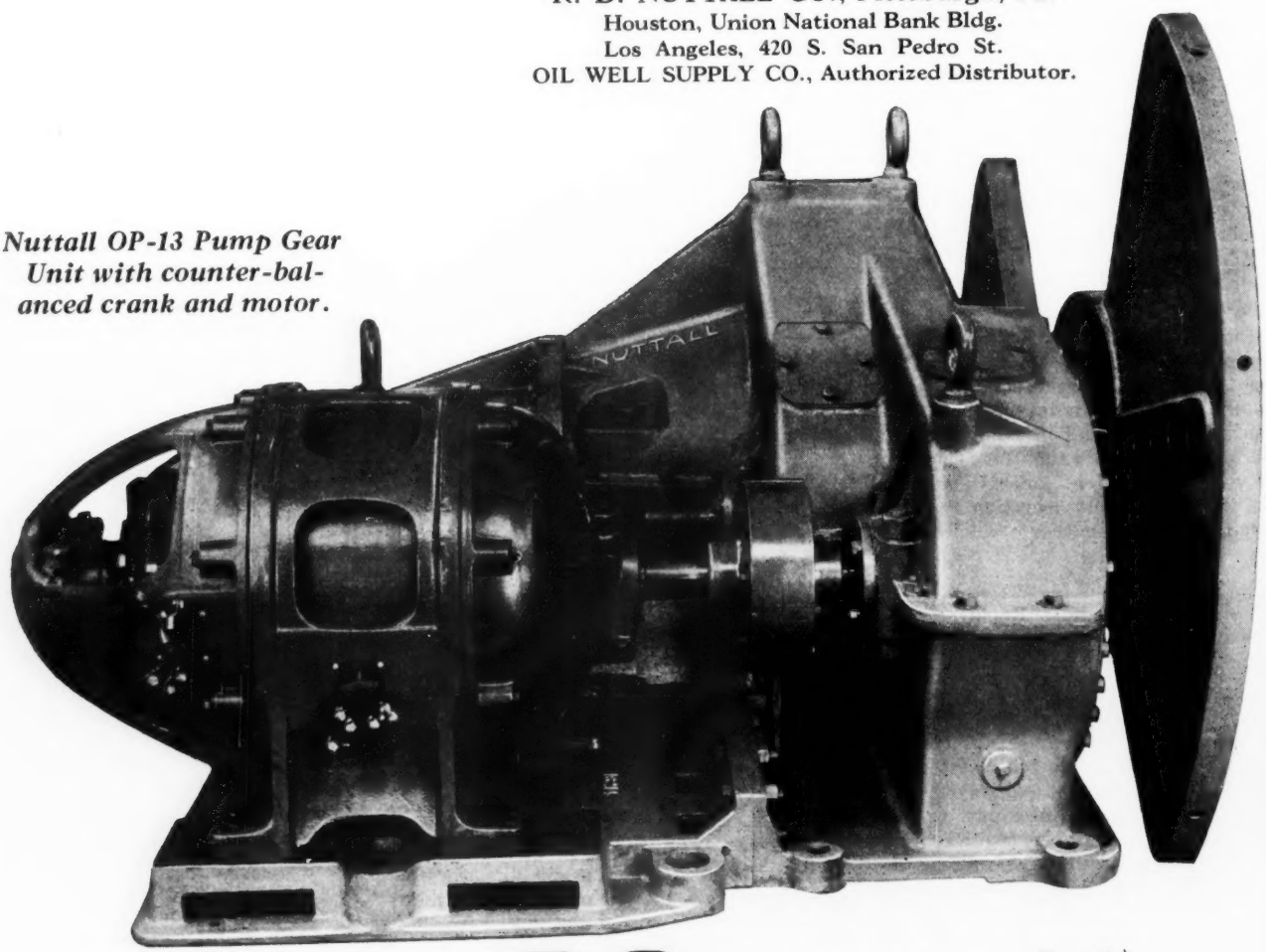

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IN THE second instance, that of the repair to pump No. 26, this work is not an emergency, and before the work may proceed, the M. O. request must have the signature of the superintendent, or assistant superintendent, and is passed to the engineering office as before, where M. O. No. 772 is made out to cover, and is forwarded to the machinist. He in turn gets in touch with the stillman, and a time is arranged suitable to both to proceed with the repair. This M. O. is eventually returned to the office as before, indicating on the face of it that the work has been completed.

All time and material on each job are charged to the M. O. number for that job. By such a record, and proper accounting, it is possible to refer at any time to any certain repair, and ascertain the actual cost. To this is added the advantage of eliminating any chance of error or forgetfulness of the mechanic and it gives him definite instruction to work to.

Now that we have outlined a system for handling repairs, we will take up a few of the major mechanical difficulties encountered in the average refinery operation, and suggest some methods of correction or efficient handling.

Boiler House Maintenance

FIRST of all, let us start with the boiler house, which is the heart of the operation, and which must send out its energy constantly and regularly that the balance of the equipment may function properly.

We will assume that we are feeding the boilers with water which, although softened, still carries some scale forming material. In other words we will look for trouble. The first place where scale formation is noticeable, is on the impellers of the centrifugal boiler feed pumps, if such is our equipment. This scale will gradually cut down the capacity of the pump as it builds up, and may eventually cause it to operate in heads, and may likewise unbalance the different stages. It has been found advisable to have an extra set of impellers available and to change them at regular intervals before the scale becomes too heavy.

If reciprocating pumps are used, we may look for trouble due to bad valves and scored liners and pistons. Bronze or a good grade of brass is the best material for these parts, and like the centrifugal pump, the pump should be inspected at regular intervals, and new valves and seats installed when necessary. A bad valve, in a pump which continues to operate will cause extensive repair to other parts, by unbalancing the pump, there-by causing unnecessary wear in the steam end as well as the liquid end.

Trouble to be looked for from scaly water in the boilers comes in the form of scale deposit in the mud drums and shells, burned tubes, choked safety nozzles, leaky safety valves, and plugged gauge columns. The main essential is to have a regular schedule for proper and systematic cleaning and inspection. It will be found advantageous to have the refinery engineer keep a chart of the boiler house, showing when each boiler is due for cleaning and inspection, so that the work may be planned in a systematic manner.

WITH the tubular type of boilers, where hand hole caps of the gasket type are used, it has been found economical to use one of the patented lead composition gaskets in preference to the various fabric or fibre type, as the former, with careful handling can be used many times, whereas the latter invariably must be renewed each time the caps are removed.

For the repair of the furnaces the writer always recommends the purchase of the best grade fire brick which should be laid up with one of the various brands of recently developed air drying adhesive cement, of which there are several. The fire brick wall set up with common fire clay, is bound to give trouble to a greater extent than one where a filler is used that will actually bond the brick. A good fire brick lining, which will stay free from bulging and expansion cracks is necessary for economy in fuel as well as the reduction of repair bills.

Most large plants have one man directly in charge of the boiler plant. Smaller plants can not always afford this overhead, however. Where this is so, it has been found satisfactory to place the boiler house operation directly in charge of the refinery engineer.

Shell Still Maintenance

SHELL stills of all descriptions, and for all purposes, present major troubles as a rule similar to those of boilers. Still bottoms, bagged or burned are common. The first essential in preventing this condition is the proper cleaning of the still, making sure that all coke is thoroughly removed down to the iron, and that the bottom is left in a smooth condition to prevent further coke adhesion.

If a still bottom continues to become over-heated in a certain spot, the trouble can be due to poor heat distribution, poor steam spray arrangement, or improper circulation, if the still is one of a continuous battery. Where the still is being forced, considerable success has been attained by using a muffle in the furnace which extends within a few feet of the back of the setting.

This muffle can be built of firebrick with sprung arches, or if properly constructed, some of the more recent types of fireclay mixtures which are set up in a monolithic structure over forms.

The heat transmitted to the bottom of the still is radiant from the arch, and the flue gases return to the front of the still along the bottom, there-by dispelling the concentration and distributing the heat over the entire bottom. The arch prevents flame impingement.

When the still bottom becomes burned to the point where a patch is necessary, the cutting torch is the best and quickest implement available for removing the burned area. Time is usually saved if shears are available, however, by cutting the patch with the shears, which will reduce the amount of chipping necessary, which precedes the caulking. The torch will also save time, in laying up the iron, if used ahead of the maul, and a tight joint will be assured.

The patch should be applied inside the still, of course, so that no pockets are formed which might accumulate coke and cause further trouble.

Fire-boxes and still bottoms, safety valves and vacuum valves, should be inspected each time a still is cleaned.

On all hot line work, it should be considered unsafe practice to use cast iron fittings. Extra heavy cast iron may be used but should be watched very carefully for it will crystallize due to the heat. It is much safer to use extra heavy malleable or standard steel, which will not only withstand the heat, but will be safer in the presence of expansion strains. Still flow lines should be constructed to be very flexible, to allow for still movement as well as expansion.

Pipe Still Maintenance

PIPE stills should be handled in a similar manner to the cracking still, but, of course, the cleaning periods are not so frequent. They should be cleaned on a regular schedule, however, according to the crude being run, which can be determined after certain running periods are tried. Where possible, the tubes should be turned after each run to prevent sagging as this will considerably lengthen the life of the tubes, and prevent them from thinning out in one place. It is better to renew a few tubes occasionally than to have to shut down a still unexpectedly which usually will interfere with the general plan of operation.

Where corrosive crudes are being run, occasional measurements should be taken of the metal in the tubes and shells of both pipe and shell stills.

This is done by drilling holes at random, and plugging them with plug rivets or tapered steel plugs, after the thickness of the metal has been noted. By keeping a record of the decrease in thickness of the metal, a fair estimate can be made as to the approximate time when repair or replacement will be necessary, the operation can be arranged accordingly, and the material can be in readiness for the work, there-by avoiding any unnecessary lost time.

Care of Fractionating Equipment

VERY little difficulty is experienced with fractionating equipment as a rule. Where bubble towers are in use, the bell caps and down-spouts should be inspected at regular intervals. At times it will be found that a plate or so below the one where the "planing" or fresh feed stock is introduced for cooling, the openings in the caps may become plugged with sulfur deposits or soluble salts that are left behind as evaporation occurs.

This condition naturally decreases the efficiency of the tower. On crude operation, salt and coke give like trouble. The quickest means of handling is to have an extra set of caps available, and to remove the dirty ones and insert the new ones, cleaning the plates and down-spouts at the same time. The dirty caps may be cleaned by hand, or in some cases may be immersed in a 10 per cent HCl solution until the scale has been dissolved. They are then ready for further use.

With wax bearing crudes, some refiners find it necessary to clean the filling in packed towers at intervals. This, however, can usually be prevented if the towers are properly steamed. Some have good results by blanking the tower and circulating discolored naphtha through it for a time.

Condensers and Coolers

AMONG the most essential parts of our equipment are the condensers and coolers. Fortunate is the refiner who has a water supply that does not scale the condensers. Where bad water is in use, this equipment should be cleaned on a regular schedule, to insure that the proper benefit is obtained from the cooling surface.

Corrosion is another enemy of condensing equipment. With badly corrosive oil, the cast iron manifold worm proves the most satisfactory. Cast iron is not attacked as rapidly as wrought iron, and the additional wall thickness adds length of life. Where corrosion is extremely bad, the introduction of a small amount of ammonia gas into the vapors prior to their entry into the condensers may be found beneficial. This is accomplished by the use of the regular pressure cylinders.

Heat Exchangers

IN CONSIDERING heat exchangers, we will also consider condensers of the shell and tube type. The shell and tube condensers give most of their trouble by the deposit of scale on the water side at the point where the hot vapors enter and the hot water overflows. Too much economy in water with this equipment is detrimental. The overflow water should, as a rule, be kept below 150 degrees to help prevent the formation of scale. If scale is formed, it may sometimes be removed by circulating a 10 per cent solution of HCl through the tubes at sufficiently regular intervals to prevent excessive deposits. The best method, usually, is to open the condenser at scheduled intervals, prior to the time that hard scale has formed, and the scale may be pushed out of the tubes with steel rods of a slightly smaller diameter than the tubes. A water lance may have to be used in conjunction with the rod.

VAPOR to oil exchangers can give plenty of trouble if they are not properly constructed and properly tubed. They should be constructed to allow for perfectly free tube expansion. Leaky tubes contaminate the condensate from the exchangers. Where such conditions exist, it has been found beneficial to use heavy tubes or tubes with upset ends. The heavy ends give added strength to the tube at the point where it is rolled into the tube sheet and help overcome the leakage which occurs at this point. Grooving the tube sheet may help in some instances also.

If salt-bearing crudes are circulated through the tubes of the exchangers, the tube section should be washed frequently by pumping hot water through at a high velocity which will help keep down the accumulation. If necessary to open the exchanger for cleaning purposes, a steam lance will be found about as good as any method that can be employed for removing the salt. Its action is to melt the salt sufficiently so it may be forced out of the tube.

Tar heat exchangers should be so designed to maintain a rapid velocity of the tar, which should pass through the tubes or pipe coil, to prevent the deposit of coke or asphaltic compounds. If the tar carries much coke or suspended matter, the exchangers were best fitted with removable heads, and flanged return bends on the pipe coils, so that the bends may be removed and the coil cleaned much after the method employed in the cleaning of the cracking still.

Residue coolers should be installed with sufficient clearance at each end of the box, so the pipes may be cleaned by simply removing the return bends.

So often the mistake is made of economizing too much on the first cost of installation and in not building the box to give ample room for this cleaning, and when the coils become plugged, or coated with a coke deposit it is necessary to remove them from the box in order that they may be turbined.

Continuous Treating Plant

MOST of the trouble experienced in continuous treating plants is with the chemical equipment and those tanks in the system which handle the weaker acid and acid waters. Pumps handling 66-degree acid should be all iron, and should be equipped with steel plate valves, sufficiently heavy to close without the aid of springs. Extra deep stuffing boxes help considerably in keeping down the packing costs, by eliminating the necessity of pulling up too tightly on the glands which scores the rods very rapidly. Where possible to install them, blow cases are far superior to pumps. They can be used very successfully to feed acid to the continuous treaters if a small regulating valve is used, and an air regulating valve is installed to insure a constant pressure.

Wash tanks and settlers for acid-treated oil have always presented a problem in the continuous treating system. The weak acid created by the presence of the wash water very rapidly attacks the plates and rivets, and sometimes causes expensive repairs. Lead lining has never been successfully used, for it is very hard to lay the lead up to the iron so that it will not break open when the plant is put under pressure. Also, the slightest vacuum will pull the lead in and cause breaks. There are several oil-insoluble, acid-resisting lacquers that come recommended for internal application for these tanks, but their use has been too short to prove their worth.

THE writer prefers a series of cast iron columns with proper means provided for bringing the oil into contact with the acid, such as the orifice plate, the perforated pipe, or spiral tile packing, in conjunction with a small intermediate tank installed between the mixing columns and the main settling tank.

Most of the weak acid or acid water can be drawn off from the small tank, and the large settler will not suffer so from the effect of the acid. Repairs to the small tank occasionally, are cheaper and easier than to the larger one, and when renewal is necessary, the cost is considerably lowered.

Caustic soda equipment does not call for as much repair as the acid

equipment. Pumps should be brass fitted, the standard brass fitted pump making a good piece of equipment for this work. Blow cases can be successfully used for weak caustic, if the quantity to be handled is not large.

All the tanks of the continuous system should be equipped with relief valves and vacuum valves. The relief valves may spill into an overflow line which will lead the oil into a small slop tank. This oil can in turn be fed back through the system from time to time.

Vapor Recovery System

THE vapor recovery system is a very important piece of equipment. Here we are dependent entirely on efficient heat exchange. Where sulfurous crudes are being run, quite some work is required to keep this piece of equipment in good operating condition if the gases are not scrubbed before entering the plant. Oil coolers and oil preheaters should be thoroughly cleaned at regular intervals on both the water side and the oil side. The same is true of the gas coolers.

The writer prefers charting each piece of this equipment and mapping out a regular cleaning schedule so that this work may be planned ahead of time in a systematic manner and in such a way as to cause no undue losses at the plant.

Where compressors are in use, the operators should be instructed to make regular rounds of the compressors, noting any overheating of the suction valves of each machine. Overheating is an indication that some of the higher temperature compressed gases are leaking back through the suction valves on the discharge stroke. This not only cuts down the capacity of the machine, but throws it out of balance, and results in undue wear.

For sulfurous gases, an aluminum piston run in a cast iron cylinder with lignum-vitae rings makes an excellent job. The rings come in sections, and are held out against the cylinder walls with light springs. Like the balance of the equipment, the compressors should have a scheduled inspection.

Lubricated valves of the core type are excellent for installation in the gas lines. Ordinary gate valves tend to corrode and stick, but if used they should be opened and closed at least once every 24 hours or oftener, and the stems should be kept well lubricated.

If pumps are used for handling the light gasoline produced from absorption plant, they should be placed so that they will have a very short suction line, without pockets, and exceedingly light springs should be used on the suction valves of such a pump so that the suction created by the pump will not lower the vapor pressure on the gasoline sufficiently to cause it to form gas, thereby making the pump gas bound.

Upkeep of Instruments

MOST plants will find it advantageous to have an instrument department if there are very many instruments, either recording or indicating in use. Most manufacturers of pyrometers are willing to take a man from the refinery organization, and give him a course in their factory in the proper care, testing, and repair, of their instruments. The same is true of the manufacturers of gauges and recording instruments.

Such a department can have a schedule for the testing of all instruments throughout the plant, and should be fitted up with the necessary laboratory instruments to make complete and competent tests and repairs. So many times, vital conclusions are drawn regarding refinery operations, the accurateness of which hinges entirely on an instrument, that this cannot be considered too seriously. If means are at hand for testing the instrument, any shadow of a doubt can be eliminated.

The testing and repair of instruments is very delicate work, and should not be placed in the hands of an ordinary machinist. If obtainable, a man who has had some jeweler's experience previously, makes a very good man for this work provided he is willing to master the essentials of pyrometry.

Keeping the Plant Clean

ONE of the large items in refinery maintenance is keeping the plant as a whole in a tidy condition. Nothing can be dirtier than a dirty refinery. Pools of oil and still cleanings are among the things which add considerably to a poor appearance. A goodly share of keeping the plant clean is dependent on the education of the operators and workmen to take pride in its appearance.

Mechanics should be instructed to clean up a job when they finish. A valve here, a piece of pipe there, and that small pile of old fittings over there in another place, would require practically no time for proper disposition, but they certainly make the place look untidy when left lying around.

A machinist opens a pump-head. Instead of taking a few minutes to provide a means of catching the oil which is in the cylinders, it is allowed to spill out on the floor. The picture is plain. He does poor work wallowing around in the oil, and excessive labor is required to clean up the mess, which could have been taken care of very easily if properly handled in the first place.

Many plants have a weekly clean-up day. This takes care of general yard cleaning, and in addition the operators are called upon to make an extra effort to clean up around their particular equipment. Paint is a mighty cheap way of keeping the plant in good appearance. In some plants, by painting five minutes now, and 10 minutes another time, the operators can keep their equipment looking ship shape, the only additional cost being that of the paint. They should be cautioned not to neglect the operation, however, for the sake of the painting but as a rule, operators who are sufficiently interested to keep the equipment looking tidy, will be careful men in their work.

Although we cannot expect to touch on every mechanical difficulty which presents itself in every day refinery life, it is hoped that some of the foregoing suggestions for handling may be useful to many. There is one rule which will apply to keeping all of the equipment in good condition, and which will cut down repair bills, and increase refinery profits, and that is simply this:

Make a systematic inspection of every kind of equipment as often as is necessary to insure that it is kept in good operating condition. Small repairs are much easier than big repairs. Equipment which is allowed to go to the point where it is in such shape that it cannot be operated without repair, invariably requires more repair time and expense than that which is properly cared for.

Describes Clay Roasting Furnace

BETHLEHEM, Pa.—Increased life to fullers' earth and increased overall filterhouse efficiency is claimed for the Wedge furnace by the Bethlehem Foundry & Machine Co., which company was a pioneer in the adaptation of multiple hearth furnaces to the revivification of filtering clays. The Wedge furnace is an earth burner for revivifying or regenerating various grades of fullers' earths in oil refining.

Uniformity of heat and a definite duration of the treatment, essential for best results, are other characteristics of this type of furnace, the company claims in a circular recently put out. In its travel over hearths, it is not subjected to direct contact with oil or gas flames.

Among some of the larger oil companies using the Wedge furnace are: Standard Oil Co. of New Jersey, Standard of Indiana, Standard of Louisiana, Humble Oil & Refining Co., Marland Refining Co., Atlantic Refining Co., Empire Refineries, Inc., Vacuum Oil Co., Gulf Refining Co., Barnsdall Refineries, Inc., and Shaffer Oil & Refining Co.

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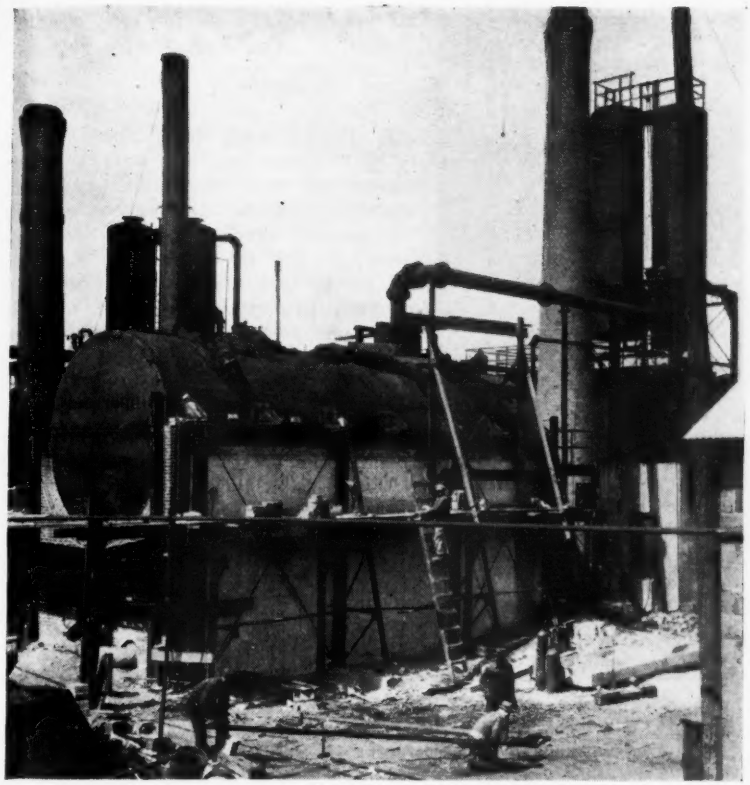


At left, asphalt still — brick setting with superex insulation ready for application of asbestos transite casing

Heat Insulation *for the* Oil Industry

By E. Rinehart

THIS article is intended mainly as a presentation of the *practice* of insulation as applied to oil refining. The theory and economics of insulation are amply covered by the works of Bagley, Heileman, McMillan* and others.

In the abstract, resistance to the passage of heat is the sole purpose of insulation, whether used for fuel conservation, fire protection, temperature control or evaporation reduction.

Therefore, the material selected must have the quality of maintaining a high resistance to heat transfer at the temperatures and conditions encountered and must be adequately protected from the weather or other factors tending to lower its resistance.

Summed up, the qualities that determine the value of an insulation (and the price will invariably be in line with this value) are:

(1) Suitability.
(2) Efficiency.
(3) Application, including waterproofing.

Evidently, the insulation must be suitable for the requirements.

With equipment temperatures from —20° to 575° Fahr., and furnace temperatures up to 3000° Fahr., with fire hazards to be guarded against, with foot traffic or compressive loads from equipment to be met, with flat shapes and curved surfaces, from pipe size to storage tanks, there is manifestly no one insulation that thermally or structurally meets all conditions.

THERMALLY, there is a definite temperature limit, either high or low, for every insulation, which marks its economical use. Further, the shrinkage and convection currents in the material at excessive temperatures will materially lower its value. Structurally, the material may be too dense for one condition where weight is a factor, or it may be too light for another condition where stability is important.

A type of material that is an excellent insulator for a bubble tower would be shaken to pieces on a tank car or pulsating pipe line. An insulation suitable for the outside of furnace settings would disintegrate from the moisture if applied to casinghead tanks. Material properly designed for fire protection of steel would not meet the demands of a wax chiller or other low temperature equipment. There are types of insulation entirely suitable for medium temperature conditions which offer comparatively little protection in case of fire at the equipment and in fact will be washed away under the action of a pressure hose.

All of these factors enter into the question of *suitability*, which can only be gauged by the characteristics of the insulation in connection with the requirements involved.

Efficiency, or percentage of saving by the insulation is primarily dependent upon the conductivity of the material, or of the several materials in combination, at the temperatures encountered, together with factors for surface resistance.

Efficiency for the length of service and not merely initial efficiency is the real point to consider.

DUE both to the marked increase in the conductivity of a material, if used beyond its established temperature limit, and to pronounced shrinkage, the original efficiency of the insulation may be decreased 50 per cent. Moreover, there may be excessive expansion or conditions that will eventually break down the insulation structurally.

Reports of tests on an insulating material are of little value unless determined for the temperatures at which the insulation will be used. Any insulation material shows an increase in conductivity with increased temperatures and some show much greater rates of increase than others.

The Bureau of Standards tests, Circular Letter No. 227 for example, done with exceptional thoroughness on a number of insulating materials, were all carried on at temperatures below 100° Fahr. and have little bearing on conditions existing in refinery equipment. Presumably, they were intended as an aid to building construction and for other low temperature conditions but even the comparative values obtained under such temperature conditions do not hold at the higher temperatures.

Of all tests, the most common one

*Presented at the Heat Transfer Session arranged by the National Research Council Committee on Heat Transmission, at the Annual Meeting of the A. S. M. E. of 1926.

of accepting the outside surface temperature of the insulation as a guide, is most misleading. Air circulation, even a very moderate wind, increases the rate of heat transfer from the surface of the insulation. This cooling of the surface in turn means a higher heat "head," or temperature difference, and results in a greater heat transfer.

AS POINTED out by Mr. McMillan, the rate of heat transfer from a surface 100° Fahr. above air temperature and exposed to air circulation of approximately 4½ miles per hour, is considerably higher than the loss from a surface at 150° Fahr. above air temperature, but exposed only to still air.

The conductivity of any recognized insulating material is established within reasonable limits and can be secured from manufacturers maintaining engineering forces for the purpose of testing all types. In addition, there has been some work done by institutional technologists and by some of the larger users of insulation.

In deciding the thickness of the insulation, the purchaser should be guided by the manufacturer's recommendations. Engineers of insulating companies have spent much time determining the economical thicknesses for definite temperatures, taking into consideration the residual heat losses, the probable number of hours per year of operation of the equipment, the life of the equipment and the capitalized cost of the insulation erected.

An accepted practice is to consider the equipment to operate 8,000 hours per year and to have a life of five years in oil refineries and similar plants having high obsolescence.

THE result of the determination, in the insulation of stills, soaking drums, bubble towers, vapor heat exchangers, residuum heat exchangers, etc., running in temperature from 300 degrees Fahr. and upwards, is to specify 2 inches of thickness of materials, such as magnesia, sponge felt, rock wool, etc., at 300 degrees Fahr. and to add ½ inch for every additional 100 degrees up to and including 750 degrees Fahr. Above 600 degrees Fahr. it is, of course, necessary to interpose high temperature insulating underneath magnesia, and this is done without sacrificing efficiency.

From 750 to 1200 degrees Fahr. the thickness usually is from 4 to 6 inches. All of the above is, of course, a thickness exclusive of the cement finish, but with the cement finish the specification gives an insulating efficiency of 93 per cent at the 300 degree range and of 98 per cent at the 1200 degree range with recognized approved materials.

Manifestly, with higher or lower costs of heat units at the equipment or with a greater or less number of hours operation, or with a different depreciation factor, the economical thickness should be modified.

Where the fuel factor does not enter into the question and it is simply a case of insulating to maintain definite process temperatures, or to prevent absorption of temperatures, as with the insulation of light oil storage, the guide is the allowable B.t.u. loss and the insulation to meet this as given by the manufacturer's specification.

As to the third point—*Application of the Insulation*—the essentials are: (1) as little supplementary metal, such as angles, strips, bands, etc., as possible, (2) as few and as tight joints as possible and (3) *above all things, thorough waterproofing.*

E. RINEHART

Mr. Rinehart, following his technical education, spent 10 years in general engineering work in this country and South America.

Work included oil pipe line engineering, experimental cracking coil development and chemical plant design.

In this was interposed overseas service in the Navy during the war, having graduated from Annapolis.

With Johns-Manville Corp. since 1920, engaged in engineering and sales work to industrials, principally to oil refineries. At present assistant manager of the oil industry department of that corporation.

A FEW years back there was a tendency on the part of plant engineers and insulation engineers, as well, to insist on a great quantity of angles, bands and clips for supporting the insulation. The result of all of this metal sticking out like a sore thumb and covered only by the cement coat, is to invariably cause cracks in the cement coat. Aside from the heat loss, there is the much more serious point of water getting in the cracks, damaging the insulation and materially reducing its value.

It is now pretty well recognized that the less the steel used for supporting the insulation, the better will be the insulation. As a matter of fact, very little angle work is ever actually required, if proper care is exercised in the selection and application of the holding cables, lacing wires and supplementary wire mesh.

The point of breaking joints in two-layer construction and particularly of making all joints tight, is often neglected, even at times by experienced insulators and heat loss through the insulation is, of course, more than anticipated. As a general proposition, other factors being equal, the larger the sheets or blocks, the fewer the joints, the more satisfactory the insulation as a whole.

The one item in the application generally receiving the least attention, but which merits the most, is the application of the cement coat, with its waterproofing—the only guard against not only deterioration, but absolute break-down of the insulation from weather conditions.

IT INSULATES to only a small extent and is designed as a mechanical and weather protection for the insulation. It has a very small amount of expansion as compared to steel, so that when applied as a whole, it is bound to crack when the tower or still expands at the high temperatures.

Nothing can be more easily camouflaged than a poor insulation job, as far as exterior appearances are concerned, until the equipment is in operation. A nicely placed, even thin, cement coat, plenty of asphalt, with the trowel occasionally dipped in gasoline, can make any job shine, in spite of defects beneath.

Time after time, we have seen the waterproofing and the cement separate from the insulation, which rapidly lost its insulating properties. Waterproofing was applied before the cement had fully set and with the subsequent driving off of the residual water in the cement it parted com-

pany with the blocks, taking the waterproofing with it.

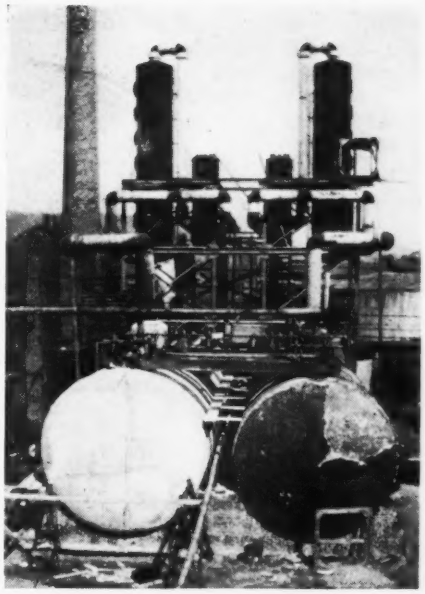
If practicable to insulate when the equipment is heated, it is better to apply only one protective coat, about ¼ inch thick over the insulation and allow this coat to partially set and to crack as the equipment reaches its maximum temperature, then, to go back with your final coat of cement, keying into the cracks in the first coat, making the total thickness of the cement not less than ½ inches.

When the second coat is well set, a plastic waterproofing, such as Insulkote, should be applied with a trowel to a thickness of about ¼-inch. You will then have a job free from cracks, highly fire resisting and one that will last for years without repairs.

All of this, of course, costs more than the usual method of simply troweling a cement coat on the insulation and then brushing on a coat of cut-back asphalt, but it is well worth the few cents per square foot additional cost to protect the dollars' worth of insulation underneath.

Cold Insulation

THE insulation of cold surfaces is a case not only of weatherproofing, but of *airproofing*, and there are thousands of feet of brine line with the insulation in deplorable shape due to the fact of never having been properly air-sealed. Air filtering through the insulation cover gets below its dew point, condenses and eventually freezes. Examination of well-appearing insulated brine lines has often developed the fact that most of the insulation beneath the outer surface is frosted; and, of course, useless.



The still on the right shows the effect of careless waterproofing

The most satisfactory sealing for cold pipe insulation, regardless of whether hair or cork is used, consists of a layer of specially prepared membrane, furnished in widths of 4 to 6 inches and wound tightly over the insulation. Sometimes, it is interposed between the layers of the insulation. The membrane is well slushed with an asphaltic or pine tar preparation.

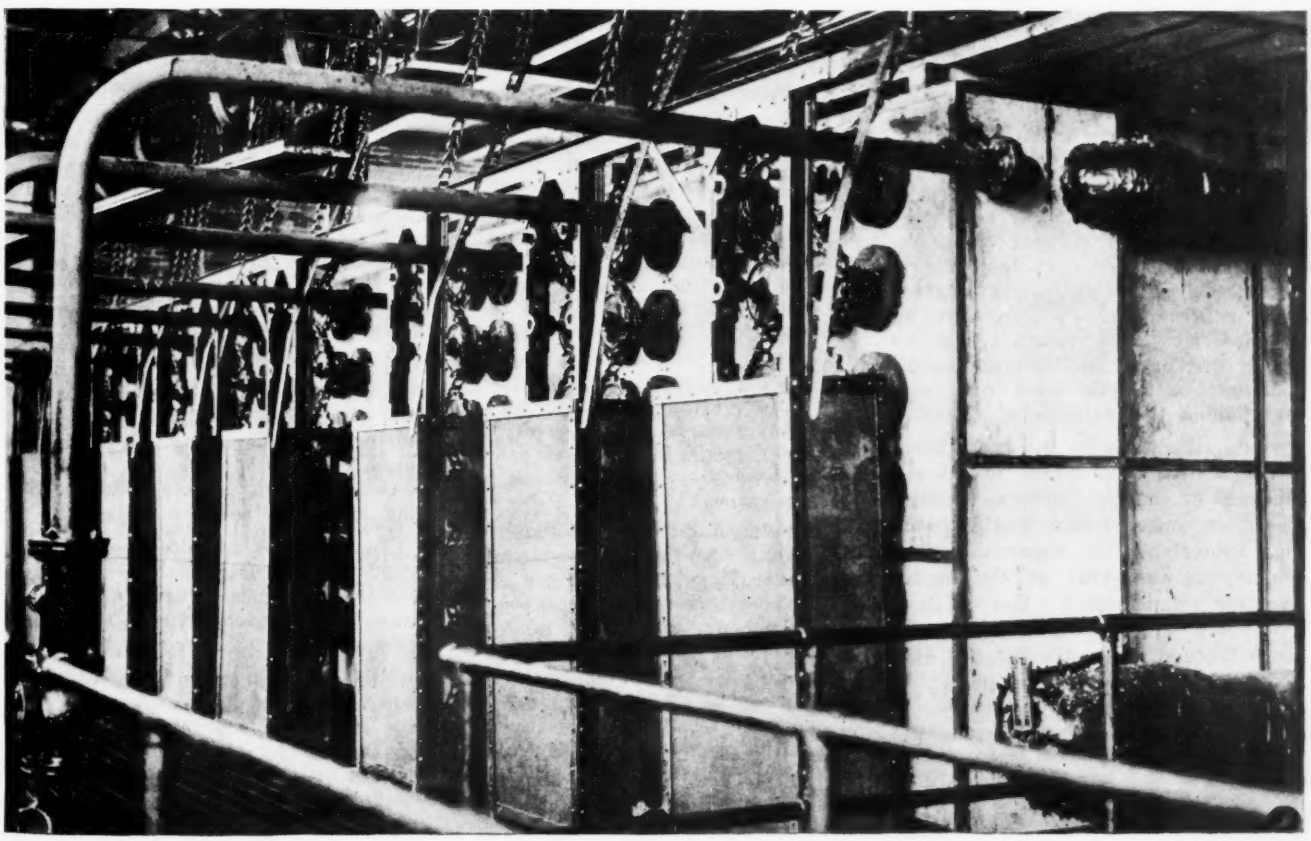
Carefully applied and jacketed with a good grade of roofing felt or painted canvas over rosin sized paper for inside work, this type of protection offers a monolithic seal that will stay tight indefinitely.

The same air tightness is necessary in the insulation of cold equipment, such as wax chillers, and is accomplished either with a welded metal housing or transite sheets on a wooden framework, gasketing the joints. Generally the chiller pipes are first individually insulated and voids filled with ground cork, as the housing is erected.

Another essential in cold insulation is that the surface to be insulated be perfectly dry. As an additional precaution, and for protection of the pipe from corrosion, it is better practice to apply a roofing felt direct to the metal surface before insulating.

In the insulation of cold lines, the pipe covering itself should be sealed off from flanges, fittings, etc., which should be insulated individually. Also, neglect of carrying the insulation well up hangers and brackets will result in frost gradually working back into the pipe insulation itself.

Because of the requirements, cold insulation, particularly for very low temperatures is far more costly to execute than is the insulation of heated surfaces. Unless this fact is



Wax chillers insulated with hair felt and regranulated cork and transite finish.

recognized and the work allowed to be done properly, it might as well be left off. Carelessly applied, it means not only a loss of refrigeration initially, but a complete loss of insulating value eventually.

Radiation Losses

IT MAY be of interest to examine the extent of radiation losses from heated surfaces in comparison with the cost of saving them. The table below is based on 8,000 operating hours per year, a fuel value of $0.30 per million B.t.u. and average air temperature of 50 degrees Fahr. A 10-mile wind increases the bare losses over 200 per cent and the insulated losses about 15 per cent.

The thickness of the insulation shown is exclusive of the customary cement finish, but the prices include the cement finish and waterproofing in place. The prices given are for average conditions in Eastern refineries and manifestly will be altered somewhat by local conditions of freight, labor, accessibility and size of the job.

Av.Operat. Temp. °F. of equipment	Loss per sq. ft. per yr. if uninsulated	Thickness of blocks or sheet insula.	Savings per sq. ft. per yr.	Approx. price of insula. in place
200°	2.8 million B. t. u.	1½″	$0.79	$0.55
300°	5.9 million B. t. u.	2″	$1.65	$0.65
400°	10.2 million B. t. u.	2½″	$2.90	$0.70
500°	16.0 million B. t. u.	3″	$4.65	$0.80
600°	23.7 million B. t. u.	3½″	$6.90	$0.90
700°	32.8 million B. t. u.	4″	$9.69	$1.05

At 950 degrees Fahr. some 70 million B.t.u. per year is the penalty for leaving one square foot bare.

The analysis of these figures shows the much higher unit losses at the higher operating temperatures. At 600 degrees Fahr., an uninsulated surface loses by radiation over eight times as much heat as at 200 degrees Fahr.

But, more to the point, *while the insulation for* 200 *degrees Fahr. returns over* 150 *per cent the thicker, more costly insulation for* 600 *degrees Fahr. returns over* 700 *per cent on the investment.* Moreover, the above figures are based on still air conditions, and a 10-mile wind will more than double the uninsulated losses.

Again, the units in the table being a square foot, the waste in leaving hundreds of flanges, fittings, manhole covers, expansion joints, steam chests, etc., uninsulated, is apparent. Particularly is this true at the higher operating temperatures. Hot oil lines of modern cracking coil equipment, where frequent inspection of the bare pipe is desirable, could be profitably re-insulated every month, if necessary, even though forced to scrap the old insulation.

At low temperatures, below freezing, where refrigeration is involved, the unit loss is much more costly. Refrigeration costing 1 dollar per ton means 1 dollar per 288,000 B.t.u.'s the thermal equivalent, so that the value of the heat absorbed, or lost by exposure is $3.50 per million, instead of $0.30 per million figured for heated surfaces.

With a room temperature of 40 degrees Fahr., an 8-inch line carrying brine of 0 degrees Fahr. will lose a considerable amount of refrigeration per year, even with a 2-inch thick coating of ice, which is sometimes mistakenly considered an insulator. Additional refrigeration must be supplied to make up for the abstraction by the ice coating, as it melts or evaporates.

Another feature in connection with the insulation of cold surfaces is that very often the available refrigeration just barely meets or fails to meet the plant requirements. By thoroughly insulating the chillers, coolers, brine and anhydrous ammonia lines and particularly the flanges, valves and fittings, the load on the refrigerating equipment may be eased to a point where additional equipment is unnecessary.

Insulated Furnace Settings

RETURNING to the question of heated surfaces, one field for economy so long overlooked, is in the proper insulation of brick settings for stills, boilers, economizers, etc.

Refiners and sales engineers will argue over a difference of a few B.t.u.'s per square foot per hour loss from the insulated surface of a tower or still and entirely ignore or pay little attention to the hundreds of B.t.u.'s per hour lost through the brick settings. Brick has a conductivity from 6 to 11, as against 0.6 to 1.9 for commercial insulators at high temperatures, so that every inch of proper insulation is equal to approximately 10 inches of masonry, in heat resistance.

A 13½-inch brick (fire or red and fire brick) with a furnace temperature averaging 2000 degrees Fahr. loses about 800 B.t.u.'s per square foot, per hour, *under still air conditions.* With 1,000 square feet of brick surface, this gives some 500 tons of coal, or 2,200 barrels of fuel oil per year, which must be furnished in addition to the process requirements, to make up for this radiation loss, if the still has 50 per cent furnace efficiency.

An 18-inch fire brick—red brick—setting under the same conditions, loses about 600 B.t.u.'s per square foot per hour and uses some 1600 barrels of additional fuel oil per year to make up for this loss.

Considering a tube still, operating at 70 per cent efficiency, with an average furnace temperature of 2000 degrees Fahr. and a wall area of some 2000 square feet of 18-inch wall, the make-up fuel for radiation loss amounts to over 2,400 barrels of fuel oil per year. Over 2,400 probably nearer 3,000, because the loss due to wind and air infiltration through cracked settings has been neglected in this calculation and is considerably more than generally supposed, a fact borne out in the insulation of by-products ovens and other industrial furnaces.

The reduction in fuel in such installations has always been greater than the theoretical amount. Usually, furnace insulation pays for itself in less than a year.

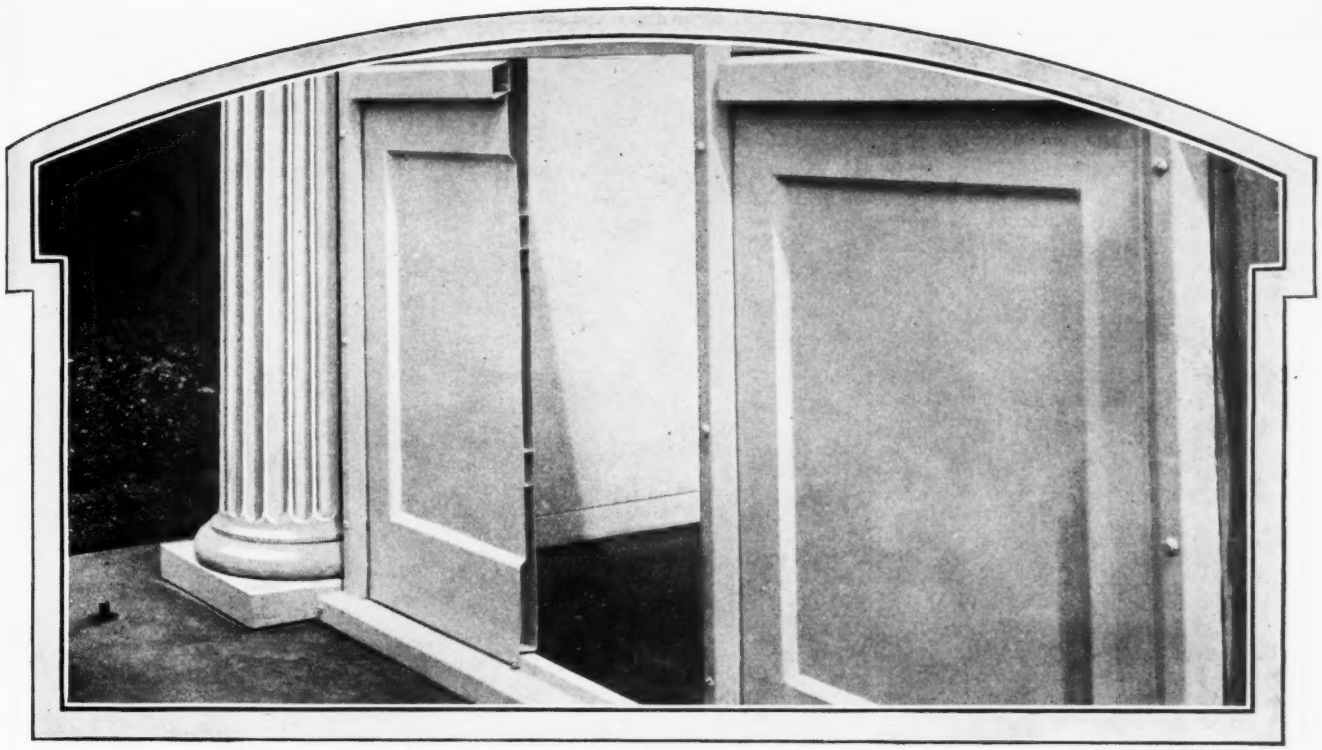
THE boiler designers, since the Bureau of Mines researches at Pittsburgh in 1903, where the air space theory was exploded, have steadily improved the design of their settings. Now we have the water walls and air cooled walls insulated, and floors insulated under ducts, with a minimum of radiation losses. The older marine boiler practice, which was really aimed at reduction in waste, of enclosing fire brick with a steel casing, lined with insulation, is the basis for one of the best industrial furnace designs including still settings, of today, asbestos transite sheets replacing the steel for economy and durability.

Essentially, the plan calls for a fire brick wall, the thickness of which depends upon the height and the furnace temperature, but usually 13½ or 17½ inches. The buckstays are set away from the wall a distance equal to the thickness of the insulation, and ⅛-inch plate with studs is spot welded to the inner face of each buckstay.

Three or four inches of insulating blocks of requisite low conductivity and negligible shrinkage at the high temperatures, are applied to the fire brick surface, in broken joint construction, with a snug fit between the buckstays and the wall.

The asbestos transite sheets, cut to size, are then laid up against the insulation, battened with No. 16 band iron and secured with 2-inch channels and nuts, as shown in figure 1.

From a construction standpoint with no tie between the fire brick and the insulation, there is nothing to be broken up by the normal expansion of the brick work, and an absence of snapping off stretchers and headers, as with the multi-type brick construction, where several materials of dif-



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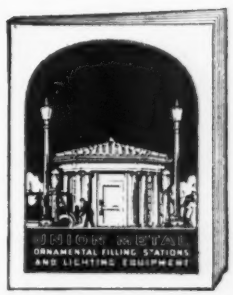

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ferent conductivities and coefficients of expansion, and exposed to widely different temperatures, are all tied in.

The use of large sheets laid in broken joint construction provides an additional seal to the ingress of air.

The resistance to the passage of heat by the insulation forces a heat flow from the hotter to the cooler part of the brick work, resulting in a more uniform temperature throughout the setting and consequently less cracking and distortion.

Effective air tightness, the full value of the insulation and thorough weather protection are obtained with this design. Applied with a 17½-inch wall, it gives the equivalent of 45 inches of brickwork as far as heat loss is concerned, at considerably less cost.

The construction is simple, comparatively inexpensive, highly efficient and has given excellent service on boilers and stills for a period of three to four years, and has been adopted for settings of tube stills and cracking coil furnaces.

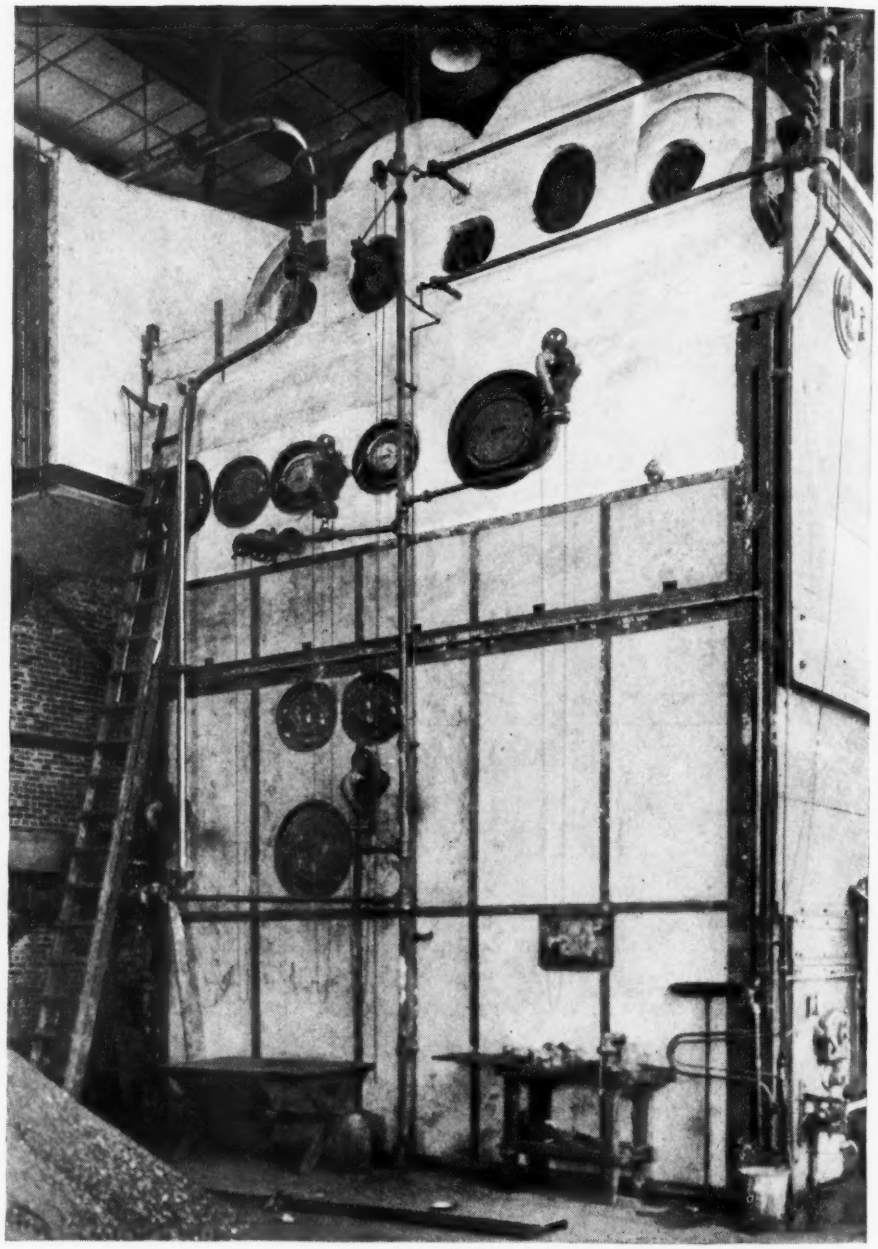
Economizers, Preheaters and Flues

THE same general design modified by eliminating the brick work altogether, has been used with success in the construction of economizers, preheaters, etc.

In this case, the transite is first made fast to skeleton steel work, the insulation blocks applied on the interior, a steel mesh or ascoloy mesh wire spread over the blocks and a heavy layer of semi-refractory asbestos cement applied as a final inside finish. This construction is not only decidedly lighter than the conventional brick setting, but has an insulating value equal to about 30 inches of brickwork and the overall cost is generally less than the brick construction of 13½-inch or even 9-inch thickness.

The idea has been used in the construction of flues and breechings of rectangular cross-section. With temperatures above 700 degrees Fahr. a steel flue, if insulated on the outside will inevitably oxidize, as well as warp and buckle, but steel flues of this and much higher temperatures have been successfully lined on the inside with insulation and the cement finish. As a substitute to the steel the use of transite is advisable, because of less expense in construction, and greater durability around corrosive conditions. The panels can be made up of transite and shipped to the job, ready for application to the angle frame.

To utilize the high temperature exit gases of stills by the use of economizers or preheaters and yet to lose considerable by radiation from the breeching or flue ahead of the equipment, is simply wasting at the proverbial bung hole.



Fire brick furnace setting insulated with superex and finished with asbestos transite sheets.

Fire Protection

IN INSULATING purely for fire protection, suitability of a material depends not only on its conductivity, but on its heat capacity. Inadequate fire protection is afforded by many otherwise good insulations, because of breaking down structurally under conflagration temperatures.

For fire protection of structural steel carrying overhead equipment, the insulation blocks should be wired on with a high temperature wire, such as nichrome and further protected by a coat of semi-refractory asbestos cement, waterproofed.

Cement in itself, while having the heat capacity, has too high a conductivity and concrete adds too much weight to overhead members. The thickness and extent of the insulation is determined primarily by the length of protection desired. Opinions of refiners vary on the desirable time, some feeling that six hours protection is essential and others that one and one half hours is sufficient.

Insulation selected for this purpose should have undergone tests of duration and requisite temperature conditions.

With an insulation specification that has successfully withstood the test of actual refinery fires, there is an assurance of definite performance of the material.

With concrete, the resistance depends considerably on the characteristics of the aggregate as well as the

The way to fight pipe line corrosion

Coat the pipe with Johns-Manville Asphalt Cement, seal on a protecting envelope of Johns-Manville Asbestos Pipe Line Felt, then a final coat of Johns-Manville Asphalt Cement outside — and the job is done to stay. The result is a rot-proof armor, approximately ¼" thick, tightly sealed against the pipe, without air spaces. This is real protection, by far the most economical.

JOHNS-MANVILLE

Oil Industry Department

Johns-Manville Corporation, Madison Avenue at 41st St., New York. Branches in all large cities. For Canada: Canadian Johns-Manville Co., Ltd., Toronto

thickness and consistency of the mix and its age.

General Insulation

TOWER insulation offers no particular problem, provided the precautions are observed as to a minimum of steel work and as to waterproofing. Where it is desired to have the seam insulation left off until after operating, for inspection, as with soaking drums, the design calls for angle clips and flat band iron, run parallel to and caulking distance away from each side of the seam. Some operators object to this practice, claiming that leaving off the seam insulation sets up leaks.

Insulation for steam lines and exhaust lines is well covered by manufacturers' data. The trend is to much greater thickness of insulation on lines, even for medium temperatures, following the practice in recent years by public utilities. Also, plants are realizing that with the valuable heat content of exhaust steam, these lines deserve proper insulation.

It is again desirable to stress the importance of proper weather protection. Miles of lines in refineries, on which the insulation cost from 50 cents to $2 per lineal foot, have insulation with less than 50 per cent of its original value. All because it had for weather protection a flimsy, rag felt roofing, which in a few years oxidized, dried out and allowed the pipe covering to become a sponge for the surrounding area.

Pipe covering outdoors merits either a good grade of asbestos felt applied with the laps looking down and thoroughly sealed with lap cement, or a heavy rag felt roofing similarly applied, painted and with another coat of asphalt paint every few years.

A recent interesting development has been the use of asbestos blanket covering for pipe and fittings, tufted, and made up with monel metal hooks and laced tight on cracking coil oil lines, which are periodically stripped of the insulation for inspection of the pipe.

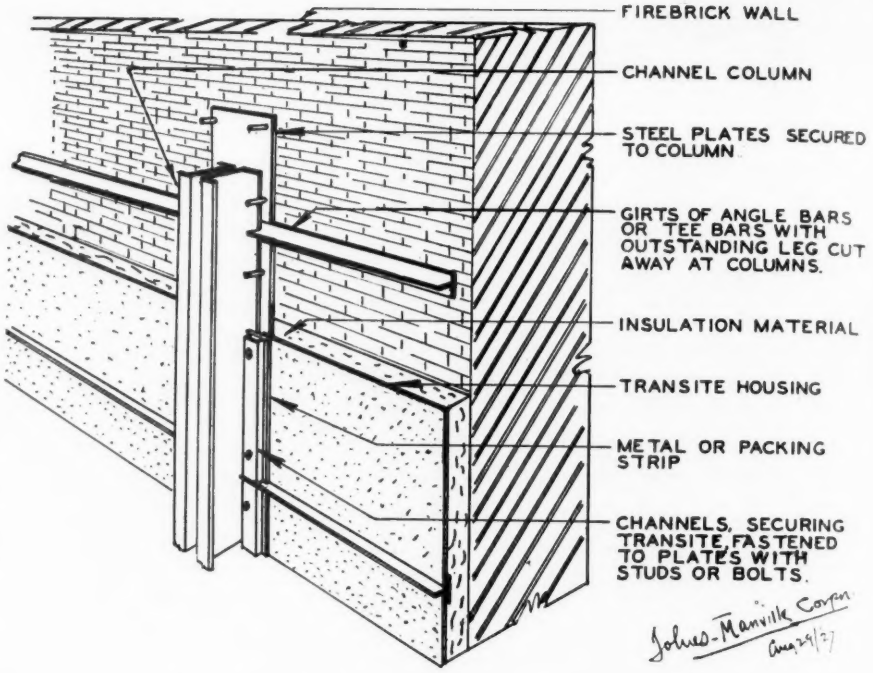
Light Oil Storage

THE insulation of roofs of light oil storage tanks for the control of evaporation is now accepted practice to the extent of some 40 million barrels. It was, of course, necessary to evolve a sealing medium which should be immune to gasoline vapors, as otherwise the insulation itself would soon break down. The seal for steel decks has been developed to a point where it is absolutely tight against a tank pressure of 13 inches of water.

With the vapor tight tank top insulation and with the pressure and vacuum valve of the Oceco type set for 13 inches, evaporation in large gasoline storage has been reduced to less than ½ of 1 per cent per year. This type of insulation yields a return in from three months to six months on motor gasoline, dependent on the condition of the tank roof before insulating.

In the storage of aviation gasoline, there is even a more attractive return to the refiner and in the case of light crude, the installation will pay for itself in from 14 to 18 months. It has been successfully applied to a number of wood decks, giving the requisite gas tightness and the combination has met the conditions where corrosive fumes of the stock made steel decks impracticable.

The insulation of shell and roof of casinghead tanks has, of course, been done for years and is of particular interest in connection with the developments in stabilized gasoline.


FIREBRICK WALL
CHANNEL COLUMN
STEEL PLATES SECURED TO COLUMN
GIRTS OF ANGLE BARS OR TEE BARS WITH OUTSTANDING LEG CUT AWAY AT COLUMNS.
INSULATION MATERIAL
TRANSITE HOUSING
METAL OR PACKING STRIP
CHANNELS, SECURING TRANSITE, FASTENED TO PLATES WITH STUDS OR BOLTS.
Johns-Manville Corp.

Perspective of insulation of still setting with transite finish.

Heated Tanks

THE insulation of heated asphalt, cylinder oil or transformer oil tanks offers the refiner not only a substantial saving in steam, but freedom of condensation drips from the roof and sides.

Insulation of a Heated Oil Tank

Size of tank—40x30 feet.

Temperature of Oil—150 degrees Fahr.

Temperature average of air—50 degrees Fahr.

Time of operation—7,000 hours per year.

Exhaust steam used for heating.

Value of exhaust steam $0.20 per million B.t.u.

Uninsulated loss in still air—roof—65 B.t.u. per sq. ft. per hr.

Uninsulated loss in still air—sides—170 B.t.u. per sq. ft. per hr.

Uninsulated loss in 10 mile wind—roof—165 B.t.u. per sq. ft. per hr.

Uninsulated loss in 10 mile wind sides—425 B.t.u. per sq. ft. per hr.

Insulated with two layers tankinsul and cement finish.

Loss when insulated—10 mile wind—roof—17 B.t.u. per sq. ft. per hr.

Loss when insulated—10 mile wind—sides—19 B.t.u. per sq. ft. per hr.

Uninsulated total loss—10 mile wind—$2530 per year.

Insulated total loss—10 mile wind—$130 per year.

Savings in cost of exhaust steam—$2400 per year.

Average cost of insulation in place—$2500 per year.

The insulation pays for itself in a little over a year. With asphalt or higher temperature storage, the return on the expense of insulation is much higher.

Up to 175 to 200 degrees Fahr. hair felt (Tankinsul) is apparently the most satisfactory material for this class of work, as furnished stitched between two layers of building paper.

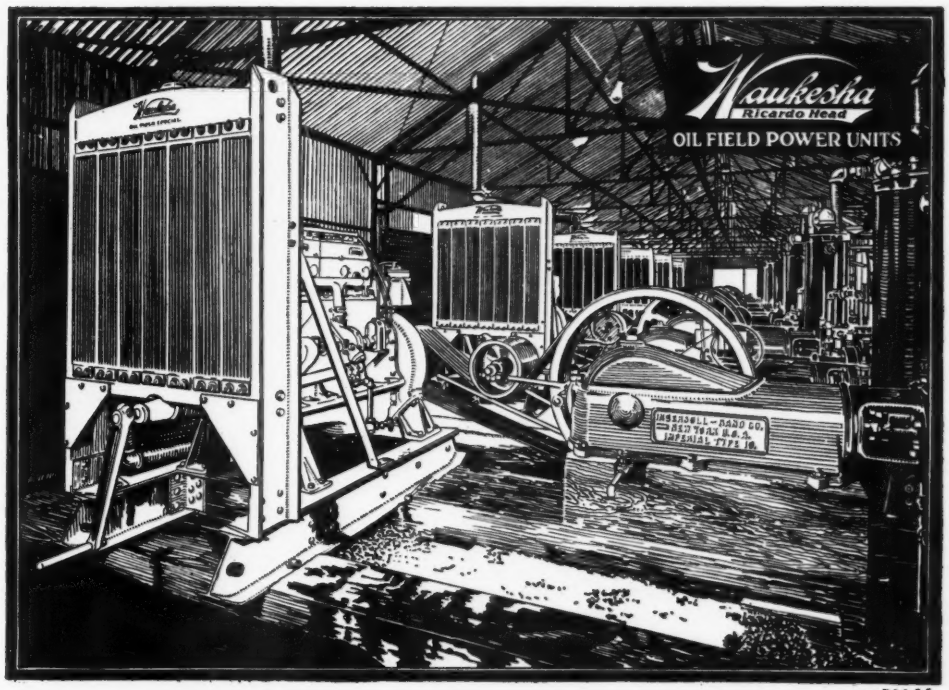
Either a cement finish, waterproofed, or a heavy white top asbestos felt are used for weather protection. Care must be exercised in making the joint around the curb angle water tight and in protecting the insulation at the bottom of the shell from ground moisture.

An ideal finish to tank insulation which can be applied in any weather is (¼-inch thick) stock transite, bent in the field to fit vertical studs on the tank, gasketed, and secured with light steel battens and nuts.

Conclusion

OUR industrial insulation has developed from the use of mud in early steamboat days to a reasonably well understood science, with ample

Waukesha Driven Gas Lift Plant at Bowlegs, Oklahoma



p-736-M

Turning Waste Into Gain

7,500,000 cubic feet of gas per day is the capacity of this plant—sufficient to lift 5000 or more barrels of oil and serve as many as 17 wells. 125 H. P. Waukesha "Ricardo Head" Engines of the heavy duty Oil Field Type, running on waste gas, furnish the power necessary to operate these Ingersoll-Rand Imperial Type 10 Compressors.

These Waukesha heavy duty four-cylinder engines are built especially for this compressor drive service. 80-100 and 125 H. P. are the sizes available. They have unusually large radiators to provide adequate cooling under Oklahoma, Texas and Venezuela temperatures, even when enclosed in a house as shown above. Portable Oil Field Units are also available for driving oil, water and mud pumps, also rotary or cable drilling rigs. Write for our "Gas Lift" book if you do not have a copy.

P-761-L

OIL INDUSTRY EQUIPMENT DIVISION

WAUKESHA MOTOR COMPANY

Waukesha Wisconsin

New York	Kansas City	Denver	Tulsa	Houston	San Francisco
8 W. 40th St.	*V. L. Phillips Co.*	*Wilson Machy. Co.*	*C. F. Camp Co.*	*Portable Rotary Rig Co.*	*C. A. Watts*

Exclusive Builders of Heavy Duty Gasoline Engines for Over Twenty Years

A Record That Inspires Confidence!

Personal contact and personal service have enabled this company to become outstanding in its usefulness to the industry.

Every detail in the manufacture of Wackman Steel Barrels is subject to the possibility of betterment, carefully scrutinized, closely inspected in process.

Piloted always by a belief in its original policy — committed to nothing except quality at the lowest possible cost!

Another Wackman plant, soon to be announced, will complete a system of efficient distribution in the southwest.

WACKMAN WELDED WARE COMPANY

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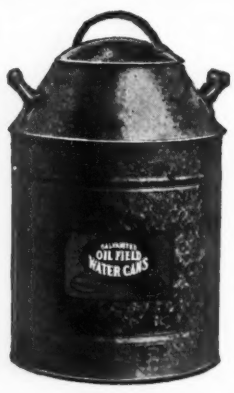

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Built to last—you will always be assured of a fresh supply of pure water, when you have a GOTT. Made in 1½, 3, 5 and 10 gallon sizes. Order now from your supply store.

H. P. GOTT MFG. CO.
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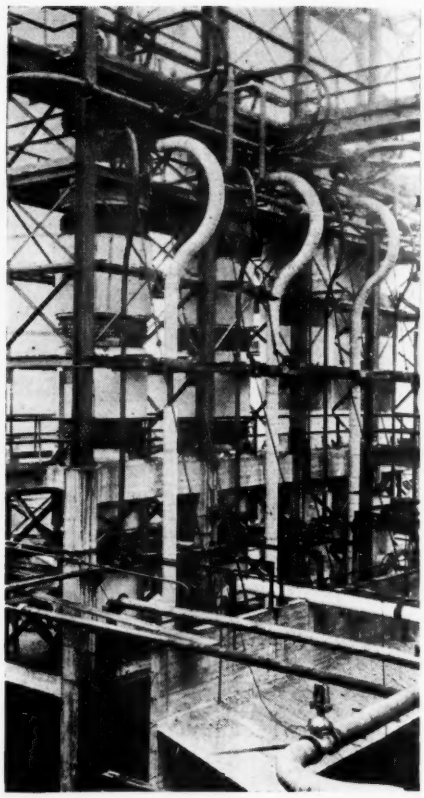

Cracking coil soaking drum insulation showing seams left bare for inspection until after first run.

engineering service and a wide range of carefully made products.

The manufacturer of insulating materials, like any other manufacturer, is in business to make money, and he realizes that to make money he must continue to furnish materials that yield a handsome return to the purchaser.

With this in mind, he is actively engaged in developing and furnishing insulation that not only meets the requirements of modern equipment, but which will allow the use of improved equipment. The manufacturer further wants to feel that the right material is used in the right place and applied in the right way, so as to insure the service expected of it.

There are few plant investments that approach the high return given by proper insulation, particularly at higher temperatures and it merits liberal consideration, periodical inspection and proper up-keep.

Bethlehem Steel Co., Bethlehem, Pa., has just published a booklet devoted to Bethlehem Diesel engines, type S for stationary service which are designed for use where an economical and dependable source of power is required. Reduced fuel oil consumption and power costs are two of the chief features of these Diesel engines, the company states, in addition to the fact that they perform all duties that steam or gas engines of similar power will perform.

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A positive displacement
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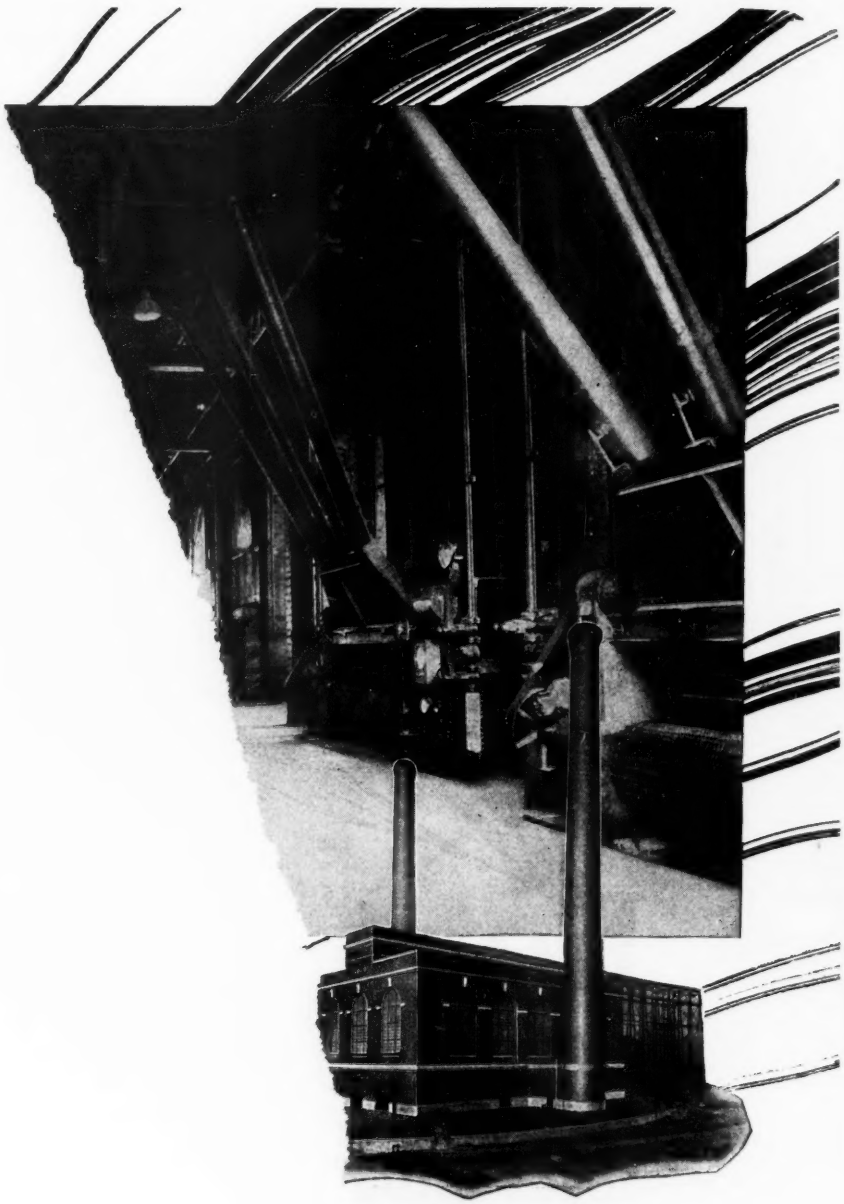

An installation of eight 755 Horse Power Vogt Water Tube Boilers in a large Eastern Refinery.

The Symbol Of ater Tube Boilers

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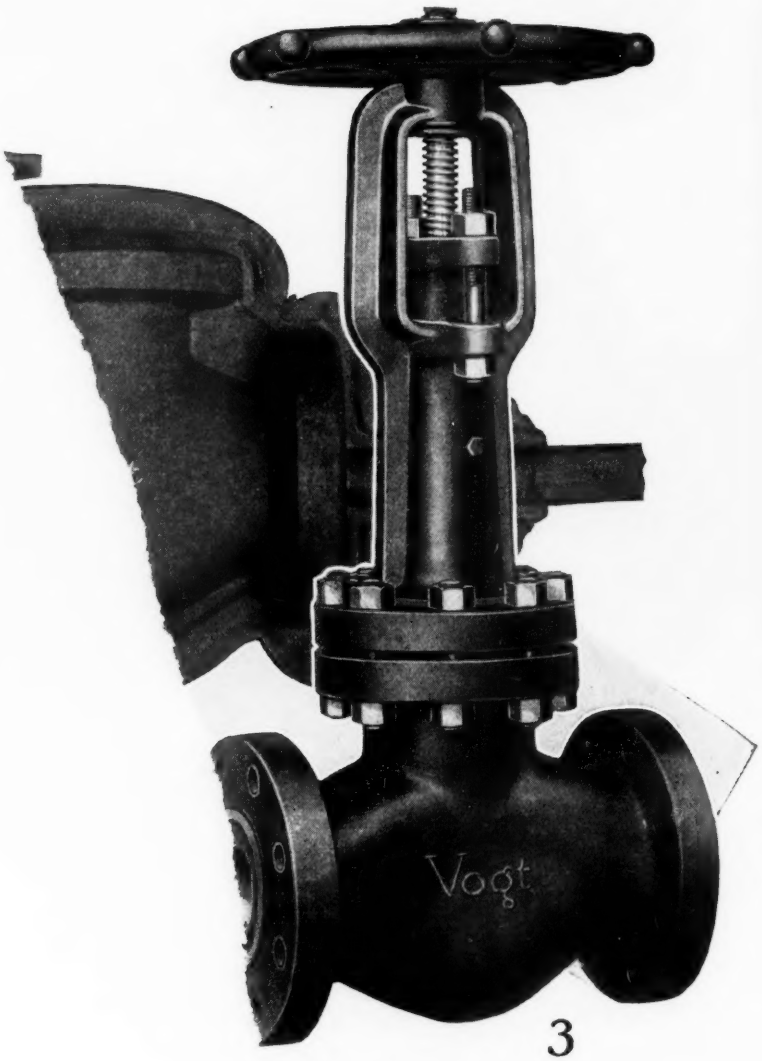

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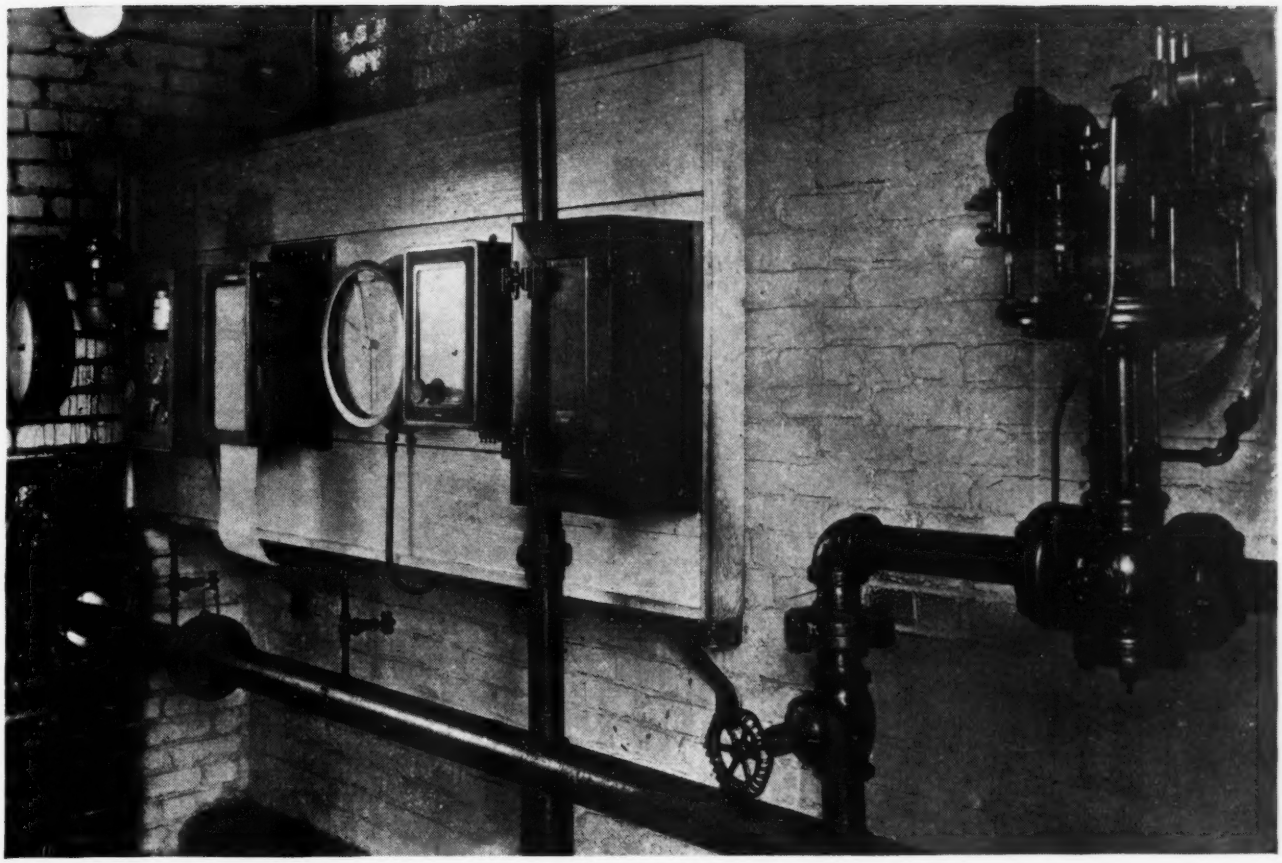


De Florez temperature control installation on Holmes-Manley battery showing, from right to left, control valve, gas-proof relay box, controller with control dial and recording and indicating instruments. Note three keys above value mechanism for adjustments to adapt control to characteristics of still

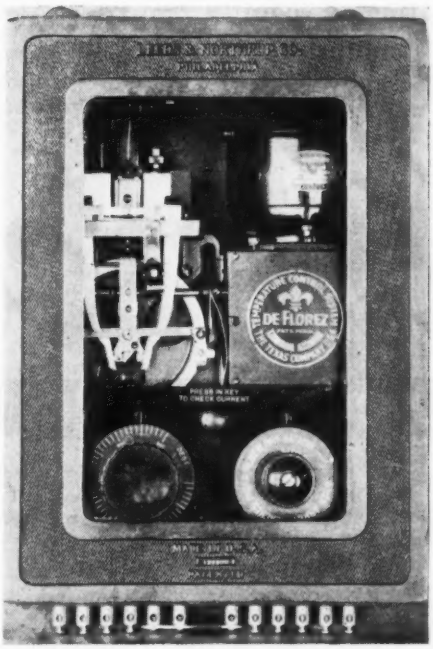
Keeping Stills at Even Temperature

By Luis de Florez

PROGRESS in the refining industry, up to the present, has been evidenced chiefly by improvement in design and carrying into practice theoretical knowledge obtained from time to time as the physical and chemical properties of petroleum became better known.

New types of stills have superseded the old; new apparatus has been devised to carry out the time-honored methods of treating; and, in fact, the modern apparatus for refining bears only a faint resemblance to the equipment considered standard a comparatively few years ago. It may be said that we have been fashioning new tools to carry out the work and, furthermore, that we have been successful in obtaining more efficient, more accurate ones, which permit us to obtain better results, if properly handled.

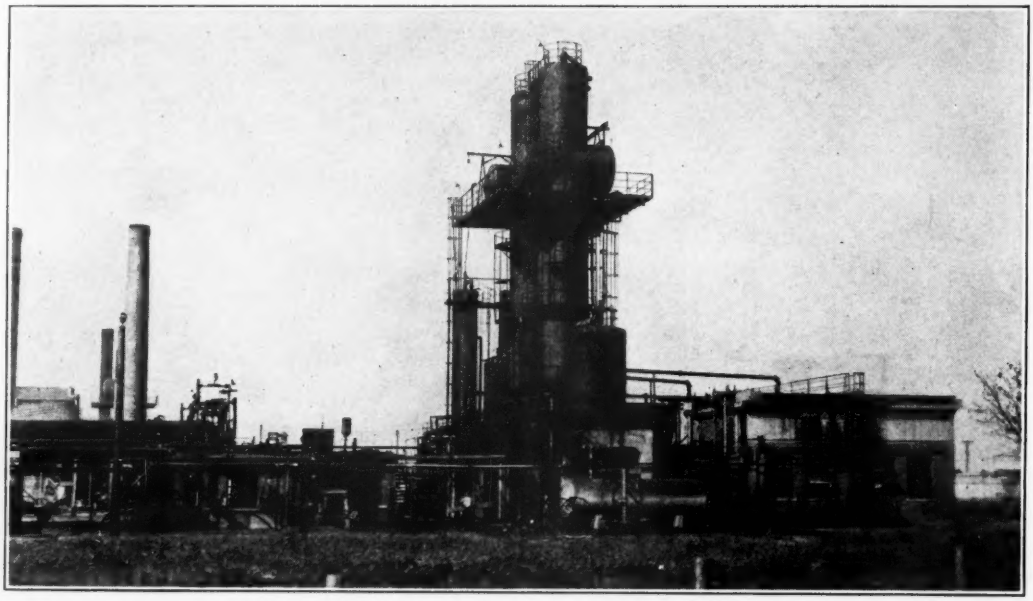
The great concern which is upon us now is how to use these tools to the best advantage, which resolves itself almost entirely to a matter of operating control. The skill of refiners has increased with knowledge and experience, nevertheless there still remains the problem of carrying out the routine of operating consistently and accurately to obtain full benefit of new design.



Controller for de Florez temperature control system showing control dial which is set for desired temperature

HUMAN powers do not change and the manual control of stills and other similar apparatus is, in some cases, possibly less efficient than in former times, due to the reduction in manual labor per unit run made possible by the construction of large units. In any case, the additional responsibility of operating larger and continuous units has so increased the duties of operators that operating facilities must necessarily be devised.

The refining of petroleum has for its basis the distillation of crude and the separation of its components by segregating products boiling between certain temperatures. In addition to this, special processing, such as cracking, is effected essentially by applying a definite degree of heat to hydrocarbons; thus it may be said



Gimco Rock Wool Installation—Pure Oil Company, Muskogee, Okla.

Gimco FlexFelt Has Highest Insulating Efficiency

—Based on Bureau of Standards Test

Meet every oil refining insulation need for temperatures from minus 50° to plus 1200° F. with FlexFelt—the most efficient insulation known that is 100% fire-proof and chemically stable. FlexFelt comes to you in blanket-like strips that fit easily and quickly into the most difficult corners and curves—a tremendous saving in installation costs.

FlexFelt is Gimco Rock Wool that has been felted and is available in a wide variety of shapes and forms. Write for your copy of our new catalog—it gives the full story of ROCK WOOL. Or, better still, send us your installation drawings or specifications so that we may quote you prices.

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GIMCO ROCK WOOL consists entirely of fiberized free silica, which has been formed by the melting and blowing of and unusual calcium silicate rock, found only near Alexandria, Indiana.

It is available in the following shapes and forms:

1. FlexFelt—standard shapes or cut to fit
2. Gimco—K-14 Insulating Cement
3. Gimco Rock Wool Insulating Block
4. Gimco Rock Wool Cork for Cold Storage Insulation.

that the control of most refining operations requires the choice and accurate maintenance of proper temperatures.

The manual control of these temperatures can only be approximate, particularly in continuous processing and it is obvious that an apparatus which will assure the maintenance of correct temperatures is not only desirable but rapidly becoming essential.

The problem of constructing such an apparatus has not been a simple one in view of the fact that to be effective it is necessary to overcome many inherent disturbances encountered in still operation; to take care of sudden and large changes as well as comparatively minute ones; to balance the operation of the still rather than to maintain it between a high and low temperature limit.

AFTER many years of experimenting, a system has been devised which is not only accurate in maintaining temperatures, but is suitable for the conditions usually met in refinery practice.

Its first application was made to cracking units where the maintenance of temperature is of prime importance and it is now successfully controlling Holmes-Manley units. The adaptation of the system to other types of cracking units and to pipe stills for ordinary distillation is now under way and it is expected that the same system will be applied to the control of the towers and other equipment where constant temperature is a requisite for maximum extraction and uniformity of products.

The system has been previously described as comprising a pyrometer element which is placed in the stream of oil or vapors, the temperature of which is to be controlled, and the potential generated by the thermocouple is registered on a galvanometer located in a controller.

The controller mechanism operates in such a manner that when the temperature has deviated from a pre-determined point, which is set by a dial, a series of contacts are made of varying duration and the effect of these contacts is then transmitted to a valve mechanism which corrects the supply of fuel to the still to maintain a constant temperature within very slight variation.

THE contacts which are made by the controller may be either applied to increase or decrease fuel. The duration of the contacts increases proportionally with the deviation from the pre-determined temperature so that there is proportional increase or decrease in fuel to the still in accordance with the departure of the temperature from the predetermined point. When the system is in balance, the galvanometer remains in a neutral position and no correction is applied in the system since this is then unnecessary.

The general effect of the controlling mechanism is to balance the still for a given fuel requirement to produce the desired temperature in the stream of oil and when this is accomplished no further corrections are applied and the system will remain inoperative until some disturbing element makes it necessary to apply corrections to readjust the temperature.

Experience has shown that a well-designed still with reasonably constant conditions of operation tends to remain in balance and that in a balanced condition the still operates at maximum capacity and efficiency. The balancing feature of the device is considered to be of great importance.

The contacts made by the controller operate a small reversible motor which, in turn, actuates the mechanism of the control valve which determines the quantity of fuel admitted to the burner. The valve itself functions in two distinct ways; first to maintain a constant pressure at the burner for any given setting and, second, to raise or lower this pressure definite amounts in accordance with the corrections initiated by the controller.

THE action of the valve is uniform regardless of the supply line pressure and is not dependent upon the valve port opening.

The second action of the valve is in response to temperature changes which act on the controller and which have the effect, with small departures of temperature, to apply comparatively small and disappearing corrections on the fuel pressure.

These corrections become greater as the departure from the pre-determined temperature increases and should a condition be arrived at where the temporary corrections are constantly applied in one direction to maintain the desired temperature, a secondary mechanism is put into operation which alters the main setting in such a manner that the temporary corrections depart from a different level or zero point.

The effect of the valve, taken as a whole, provides a small or delicate adjustment when the still is approximately balanced and a pronounced correction with sudden large changes or emergency conditions.

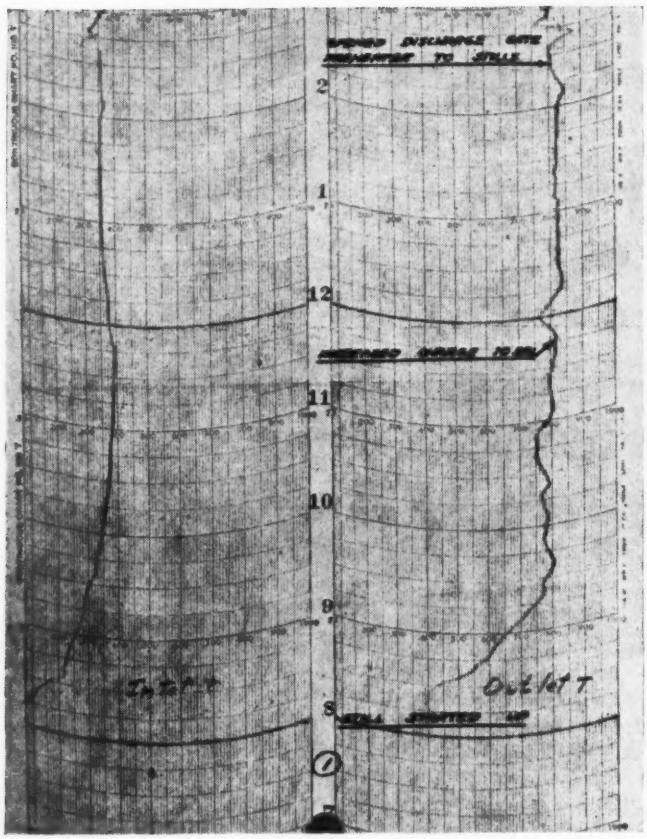
The system eliminates hunting and controls the whole of the fuel used by the still. It will act rapidly in case of emergency but at such speed that no undue strains are put on the heating surfaces or the furnace settings. Adjustments are provided for the extent and speed of the corrections to suit conditions, likewise for throwing the automatic mechanism at any time if it is desired to operate by hand.

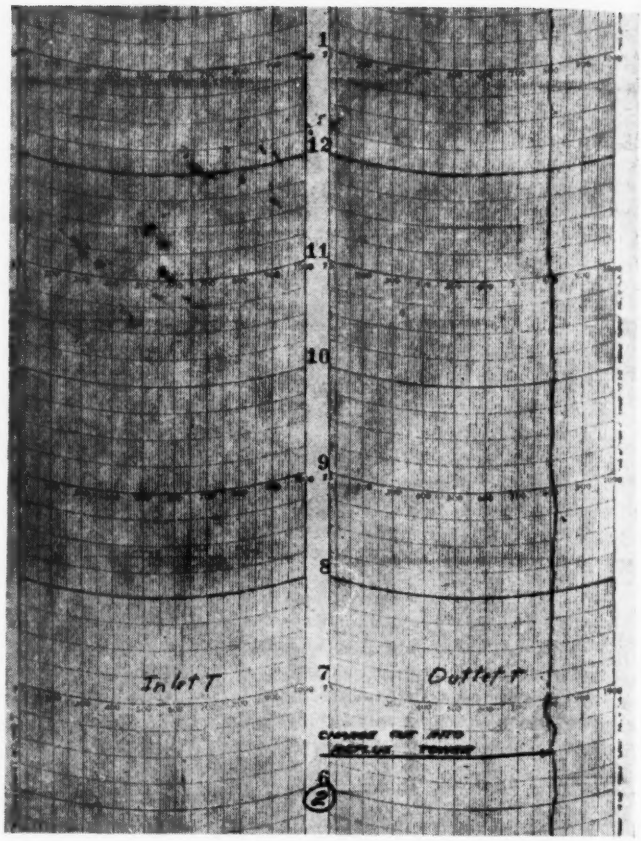
IN OPERATION on the Holmes-Manley units the control of the outlet temperature has a distinct stabilizing effect on the operation of the whole still and as a result of the maintenance of constant temperature, fluctuations in pressure, circulation

LUIS De FLOREZ

Mr. de Florez has been in petroleum engineering practically ever since his graduation from Massachusetts Institute of Technology in 1912. *His first work was in connection with vapor phase cracking, the first units being built in England and operated during the war for the manufacture of toluol and benzol. Later he built several vapor phase units in this country which operated successfully.*

For the past 10 *years Mr. de Florez has been engaged in refinery engineering except for a year or so during the war when he was put in charge of design and construction of air craft instruments for the navy. Since the war he has designed a number of refineries and just before going into consulting work was chief engineer of the New England Oil Refining Co. He has spent several years working on various phases of cracking and the development of temperature control. This work has been done in conjunction with The Texas Co. whose interest and help, he says, has made it possible.*





Charts 1 and 2 above show temperature line at two periods during the starting of the still. No. 1 the initial firing where the dial is set for the approximate temperature desired and the effect of changing the flow and opening up to stills.

No. 2 the effect of opening reflux into the towers and the subsequent temperature line. It will be noted that no hunting effect is apparent and that the controller takes care of wide variations in conditions.

and feed are practically eliminated. The stills can also be brought on stream with the apparatus and it is capable of taking care of emergencies such as the possible failure of the circulating or charging pumps should the occasion arise. The temperatures can be maintained over long periods within a range of 5 or 6 degrees Fahr. and in many instances no appreciable variations over considerable periods of time.

The accurate temperature control at all times in refinery operations is obviously of great importance and will lead to more accurate and uniform results and permit expensive equipment to be run more nearly at a maximum output on an average.

Practically any continuous heating process can be controlled within a few degrees of the required temperature without recourse to the skilled firing and an added safeguard can be obtained in case of sudden unforeseen changes which reduces the possibility of accident and, in any case, reduces the possibility of spoiling products.

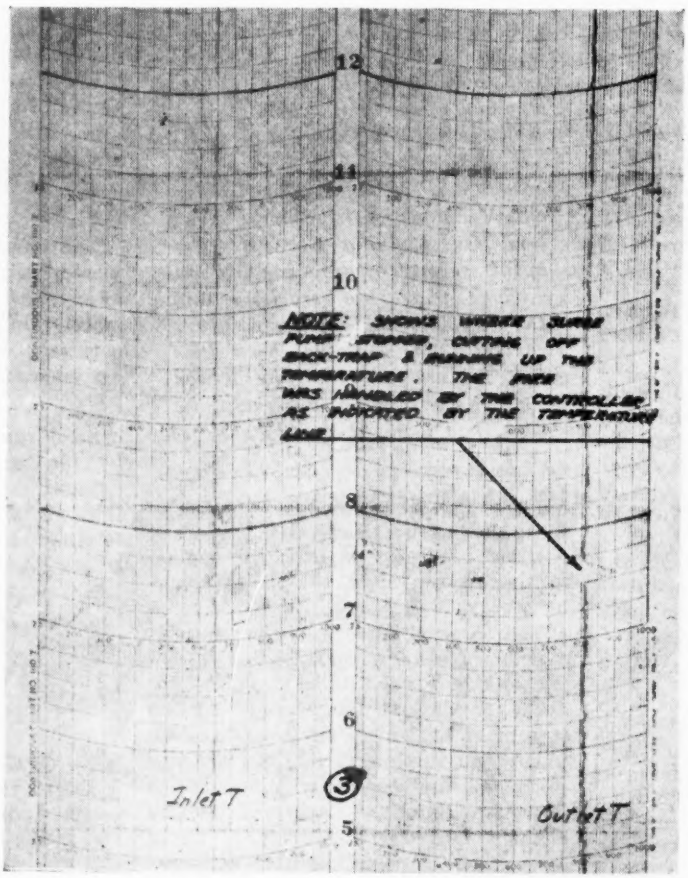


Chart No. 3 above shows effect of stopping the surge pump which materially decreased the circulation in the still. The controller is able to compensate for this with a rise of about 80 degrees and return the still to normal without drawing the system into cyclic hunting. Also it will be noted that it has compensated for throwing the surge pump back into operation with little effect on the temperature line.

The equipment required to do this is comparatively inexpensive when viewed as a percentage of the total investment of the unit to be controlled and, since it is a factor which makes possible a maximum realization on investment, it should be considered in the light of an integral part of the apparatus rather than an attachment.

It is felt that the correct principle of temperature and control has been arrived at and that the broadening of the uses of the control system is merely a matter of adaptation to the various duties required.

Adding a word with regard to automatic control in general, it is to be expected that in refinery design and operation in the future automatic control will not be limited to the maintenance of temperatures but to the regulation of flow and pressure which today are accomplished by hand,

and that the goal which we should strive for is a unit in which operating conditions will be maintained at given relation to each other and that the only necessary action of operators will be to see that these conditions are proportioned in such a manner that the unit will give the best results.

In this day and age it would be considered that a steam engine is incomplete if it were not fitted with a speed governor and yet, in a way, it is no different to control the speed of a pump by hand or to adjust the firing valves of the still to give the correct heating effect.

A power plant operator may alter the setting of the governor to give him desired results but does not have to watch it after he has altered the setting. Likewise in distillation or treating we should be able to determine the degree of heat we desire or the amount of flow or pressure required and be concerned only with these settings and not the maintenance of the conditions.

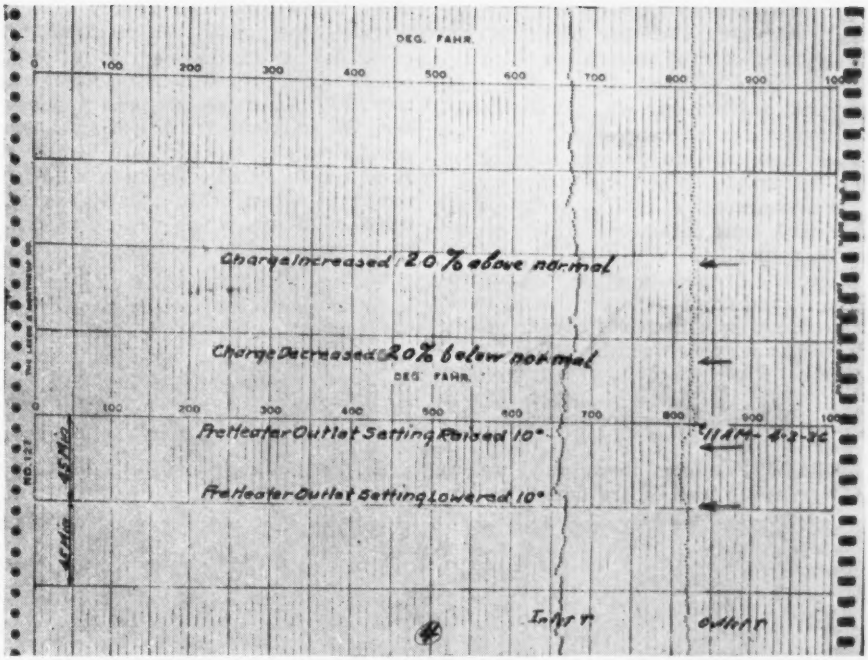

DEG. FAHR.
Charge increased 20% above normal
Charge Decreased 20% below normal
DEG. FAHR.
Pre Heater Outlet Setting Raised 10°
Pre Heater Outlet Setting Lowered 10°

Chart No. 4 above shows the effect of reducing the dial setting 10 degrees and later increasing the dial setting 10 degrees, also the effect of decreasing and increasing the charge to the still. It will be noted that the reduction and increase takes effect with no hunting and that the change of 20% in the charge is taken care of by the controller with no appreciable effect on the temperature line.

Temperature Control In Refining Operations

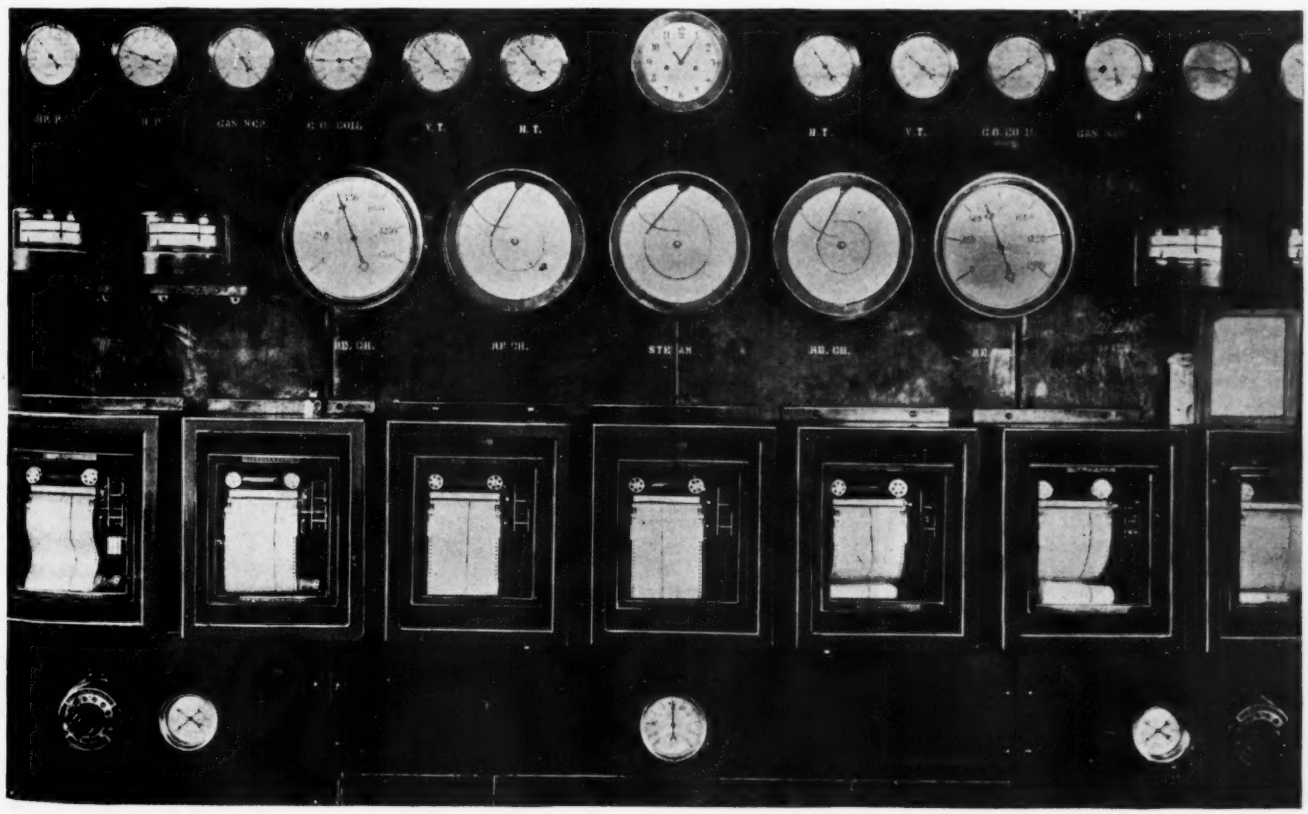
By Richard P. Brown*

TREMENDOUS strides have been made in recent years in accurate temperature control at vital points in refinery operation.

There are very few industries where maintenance of a definite temperature within close limits is as important as in oil refining where the yield and fuel consumption may be seriously affected by a change of a very few degrees in the temperature.

To maintain such close temperature regulation by hand, becomes such a burdensome job that operators naturally fail to obtain 100 per cent control, whereas a properly designed automatic temperature control working day and night, relieves the strain on the operator and does automatically what the operator tries to accomplish by hand. Wherever automatic temperature control has been applied successfully in

*President Brown Instrument Co.



A typical control instrument board in a refinery.

refineries, the operators using the apparatus would seriously object if the automatic control was removed.

They are relieved of the continual manual adjustments which were necessary under hand control and they can give their time to general supervision of the unit.

Furthermore, it is frequently possible with automatic control to operate with a smaller force than is required where the fireman must be making frequent hand adjustments. This in itself can result in a material saving yearly in personnel which can be utilized elsewhere.

Furnace Temperatures

STARTING from the ground up, so to speak, one of the first temperatures to be controlled in any refining process, whether it is a cracking process, lubricating plant or ordinary crude still, is the furnace temperature. Whether this furnace temperature is maintained in relation to the temperature of the hot oil heated by the furnace or directly as a result of the furnace temperature itself, depends upon conditions which will be referred to in greater detail below.

The main point is—If the hot oil is to be maintained at the proper temperature to obtain the greatest yield, the furnace burners must be adjusted to give the proper furnace temperature. Some of the objects of controlling the furnace temperature are:

A. To maintain uniform heat distribution to the tubes in a tube still or below the shell in a shell still.

B. To maintain a constant and continuous heat application.

C. To maintain a furnace temperature as high as possible with regard to maximum life of the tubes and furnace masonry and to prevent overheating.

The Tube Still

LET us first consider the tube still. Let us assume that we have a constant rate of flow through the tubes due to a constant pump speed controlled by a suitable regulator. With a constant throughput, if we maintain a constant furnace temperature, we will maintain a practically constant hot oil outlet temperature. Experience has shown that abnormal weather

(*Continued on Page* 114)

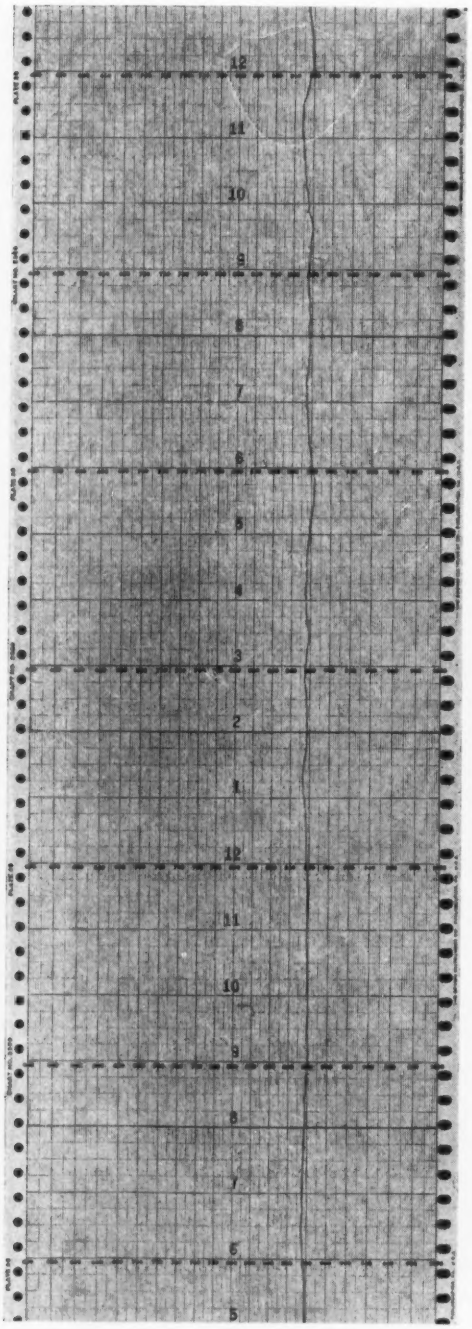


Chart showing hot oil outlet temperature of the tube still under manual control.

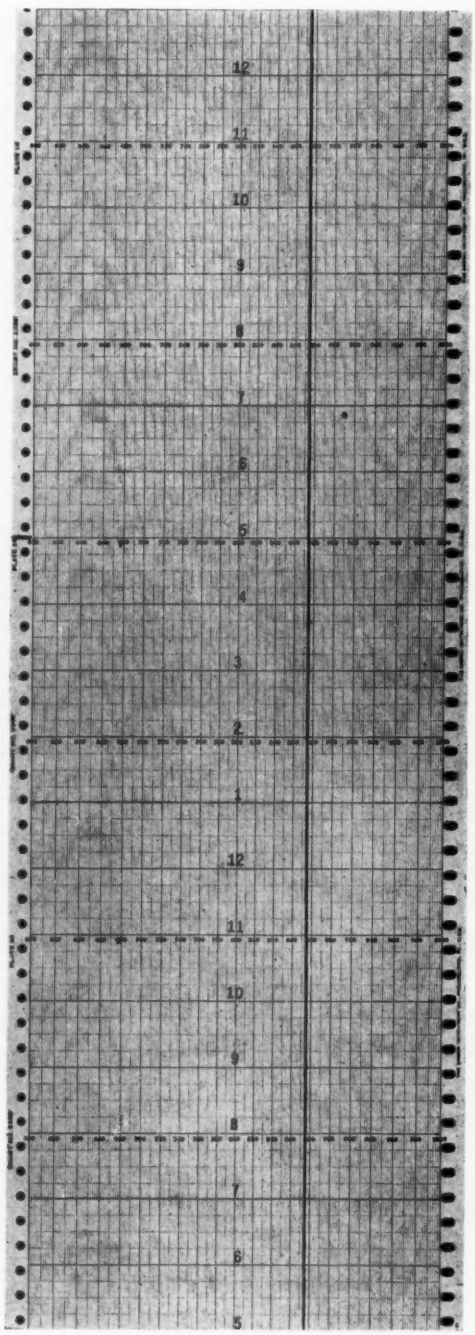
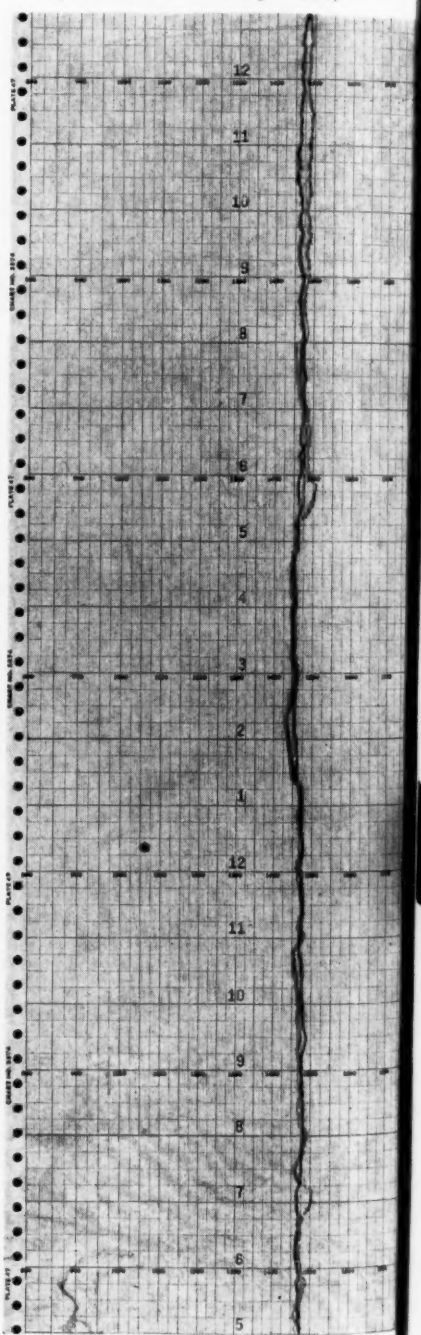


Chart showing hot oil outlet temperature of tube still under automatic control.



Section of chart record showing four furn records of temperature for tube still furn

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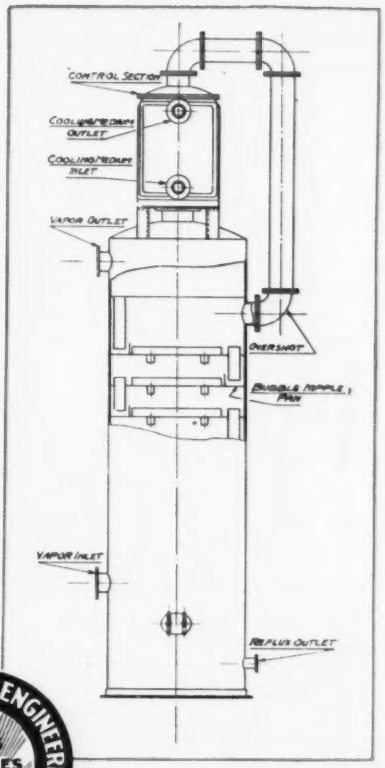

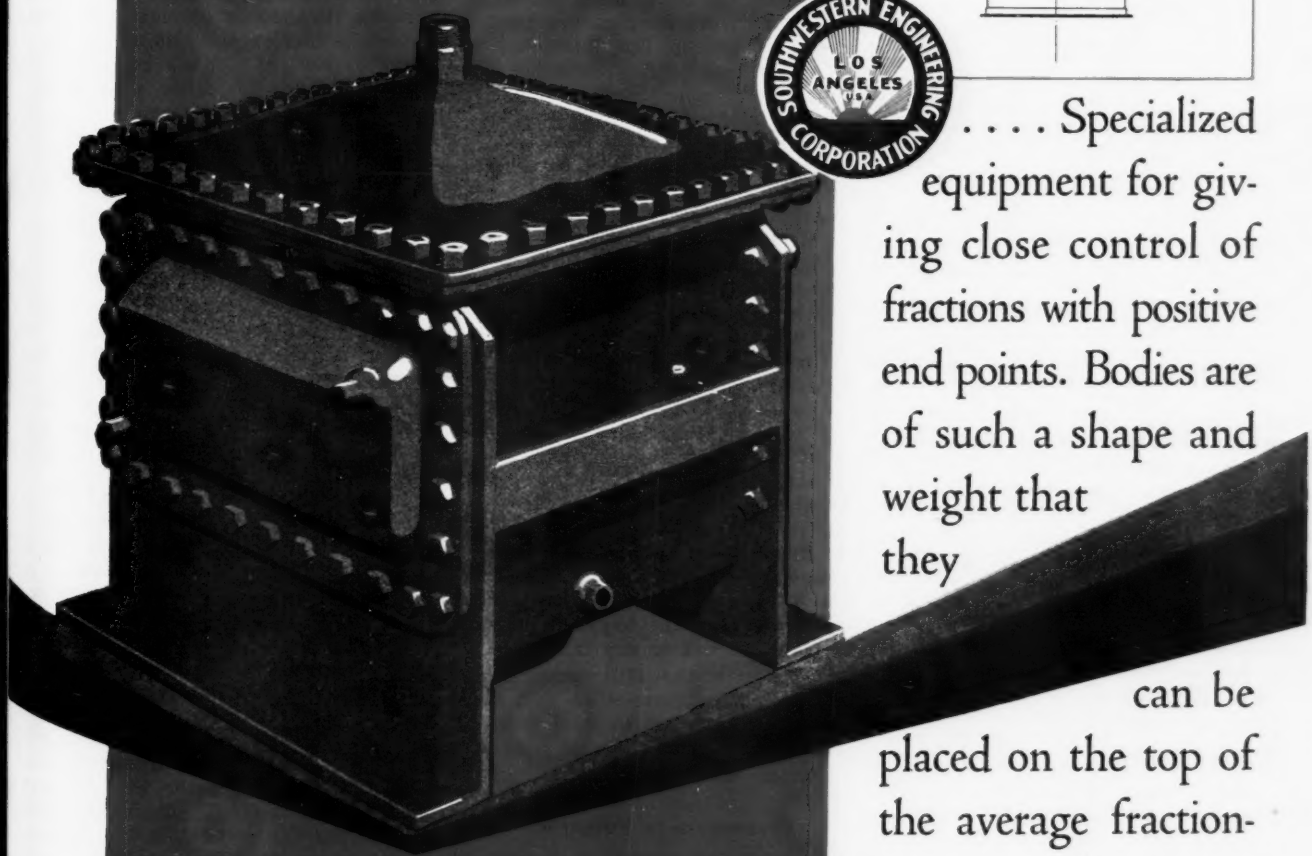

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(*Continued from page* 112)

conditions may require adjustment of the furnace temperature, not because the furnace responds to such weather conditions because it is too well insulated, but because the oil line leading to the still while insulated, is not usually insulated for water and can be readily chilled by a cold rain or hail storm.

Where a plant has steam operated pumps delivering oil to the tube still and they have sufficient steam and a suitable regulator to accurately control the pump speed, a constant throughput is easily obtained. Furthermore, where electric driven pumps are used and the power supply is constant, a constant throughput is readily obtained.

Under such conditions, direct control of the furnace burners from the furnace temperature, will normally give a constant hot oil outlet temperature. Where, however, the steam capacity of the plant is insufficient, or the power supply for electric pumps is not constant, the most satisfactory control of the burners is from the hot oil outlet temperature. A control of the burners can also be obtained from the furnace temperature with means in the controller for automatic adjustment if the hot oil outlet temperature varies from the desired temperature.

Tests have shown that a much quicker correction can be made for any change in the furnace temperature if the primary control is from the furnace instead of from the hot oil leaving the still. This is natural because the furnace temperature changes approximately 10° F. for a change in the hot oil temperature of 3° F.

Furthermore, the changes in the hot oil temperature must necessarily lag some minutes behind changes in furnace temperature because primarily it is the change in the rate of throughput or the change in furnace temperature which subsequently results in a change in hot oil temperature.

Experiments have shown that where a unit is operating with insufficient steam to obtain a constant throughput and the regulator cannot function properly, what the operator does, provided the hot oil outlet temperature changes, is not to change the furnace temperature but to readjust the pump speed so that with a greater or lesser steam supply, the pump actually maintains the same throughput. If the operator under such conditions changes the furnace temperature, the throughput would be constantly fluctuating and continual adjustments would be necessary, disturbing the heat balance to the furnace. To conform to what the operator does where such conditions exist, it is best that the controller maintain a constant furnace temperature and the pump speed regulated from the hot oil temperature to maintain a constant throughput regardless of fluctuating steam pressure.

Shell Still Control

With shell stills, the problem is an easier one as we do not have the variable quantity, throughput. With a shell still, a constant furnace temperature can be automatically maintained to give a much better control than is possible with hand regulation and without consideration of any variables such as throughput.

Control of Tower Temperature

ANOTHER vital temperature to be controlled in any refinery is the tower temperature. Control is easily obtained in relation to the outlet temperature of the tower. Proper control of this temperature generally speaking results in a uniform quality of the product.

It does not necessarily mean that this quality will remain uniform under all conditions for a given tower temperature but it is a good index of quality. Accurate temperature control of towers used on the fractionating end of pressure stills has been accomplished for some years with the so-called "on and off" type of temperature control.

This type of temperature controller makes a saw-tooth record line but the fluctuations to either side of normal are only a very few degrees. This so-called on and off control producing a saw-tooth record can now be replaced by a proportional type of controller which makes a correction in relation to the amount of cooling medium required and which eliminates the constant ups and downs forming the peaks obtained with the on and off type of controller.

Consideration has been given in connection with towers for crude stills to the following schemes which have possibilities, and experiments along this line are being tried.

(A) To maintain a constant amount of reflux through the top of the crude tower, either "wet or dry trim."

(B) To vary the still temperature by means of the furnace so that heat input into the tower would be varied to maintain the desired vapor temperature at the top of the tower.

Pyrometers in Furnaces

WHILE the furnace temperature and the tower in a refinery are the chief temperatures to be automatically controlled, it is very desirable that the furnace be equipped with several thermocouples connected to an indicating pyrometer with a switch or a multiple recording pyrometer so that the temperature throughout the furnace may be regulated to secure an even heat distribution to the tubes. A multiple recording pyrometer is particularly desirable for this service as the various record lines representing the temperature of each thermocouple in the furnace can be held close together and the chart will show whether even heat distribution is being obtained throughout the run.

By means of a multiple automatic controller connected to several thermocouples in the furnace an even heat distribution can be automatically maintained without hand adjustment.

It is also desirable to have an indicating or recording pyrometer on the bottom, top and other points of the fractionating tower. These temperatures enable the operator to know that the tower is doing the work that it should, that the refluxing is being done to the extent to be expected, that the majority of gases are not escaping without being properly refluxed and the heavier ends thrown back.

Gas Analysis Apparatus

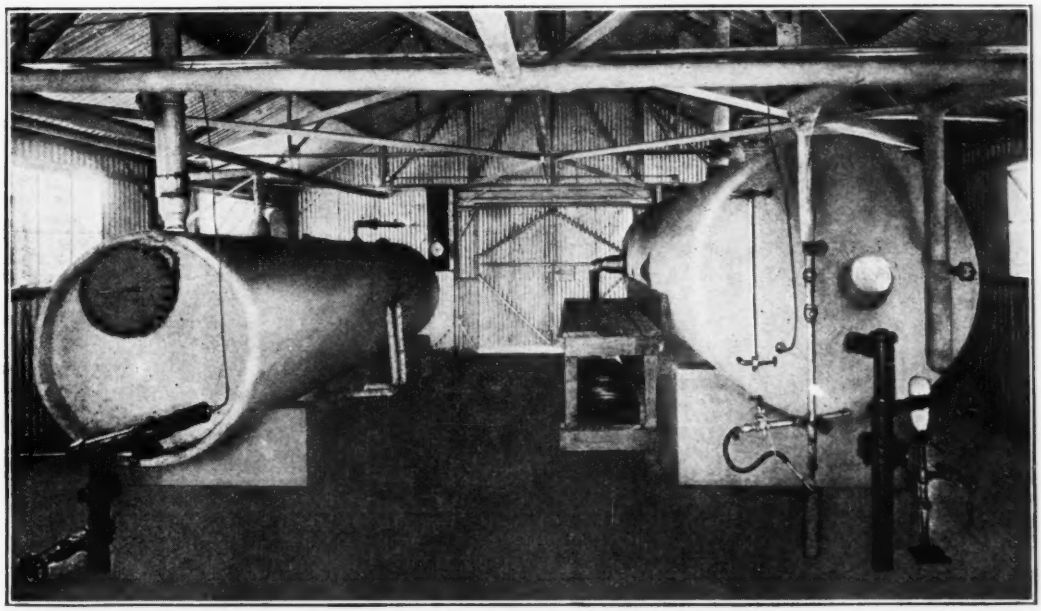
PYROMETERS and gas analysis apparatus are desirable on the flue gas circulating system to get the proper distribution of recirculating gas. For this application it is good practice to use a duplex recording meter showing on one side of the chart the CO_2 content of the recirculating gases, and on the other side of the chart, three temperatures: namely temperature of the stack, temperature of the flue gas entering the preheater, and temperature of the preheated air outlet from the air preheater.

This enables the operator not only to determine the efficiency of the preheater but to regulate the temperature of the excess gases and the preheated air to the furnace from the standpoint of best economy as well as keeping the furnace full of hot gases. This latter thought, namely the keeping of furnace combustion chambers full of hot gas, is not to be discounted in any way.

In fact, with the low rate of transfer of heat into oil, this is extremely important. In some cases it is found desirable to run at a comparatively low and inefficient CO_2 content, for example 6 per cent, to insure the presence of a large amount of hot gases in the combustion chamber and thus promote the rapid transfer of heat into the oil.

This means that combustion efficiency is sacrificed under such conditions to give a greater rate of heat transfer to the oil. Automatic control of the CO_2 content in the recirculating gases has been obtained in certain refineries through the control of dampers or fans from an automatic CO_2 controller.

Undoubtedly tremendous strides have been made in the last few years in the application of temperature measuring and control instruments in the process of oil refining. Undoubtedly great benefit is obtained where instruments are available to tell the operators exactly what temperatures are being maintained at various points in the process.



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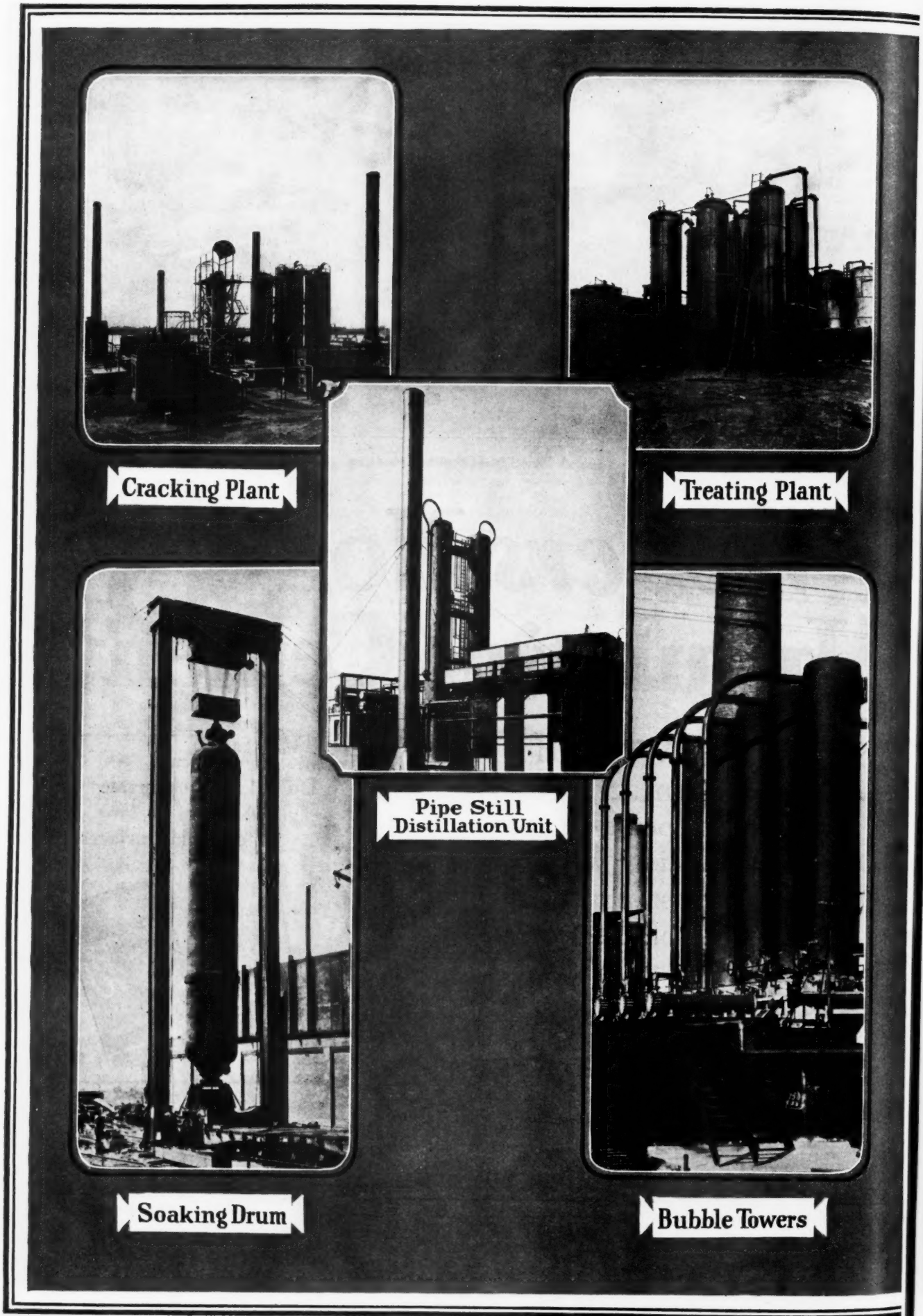
Cracking Plant
Treating Plant
Pipe Still
Distillation Unit
Soaking Drum
Bubble Towers

Methods of Temperature Control in Refinery and Gasoline Plant

L. G. Marsh*

THE importance of temperature indicators, recorders and controllers in refineries and natural gasoline plants is coming to be more broadly recognized through their vital relationship to standardized procedure, economy of operation, and uniformity of quality in the finished product throughout a continuity of plant operations.

In distillation units, fractionating towers, refrigerating processes, wax sweaters, etc., indicating thermometers are essential for the control of the various steps in operating procedure, and the conversion of this indication to an infallible record form has made the application of the recording thermometer an equally vital aid in most efficient plant accomplishments.

Recording thermometers properly applied furnish an absolute check on the efficiency of employees and apparatus. In this connection we desire to quote from a recent article which sounds the keynote of the application of the recorder:

"Recording thermometers are the compass for a plant operator. They chart the sea for the plant superintendent. They show him at the end of a day's run whether or not the operators are steering straight. The old timers will tell of determining boiler water levels by rapping the shell with a piece of pipe, or getting still temperatures by listening to the sizzle of tobacco juice. But today is the day of big business. Consolidation of smaller entities is natural. Big business has created big jobs and big men fill them, men who not only know how, but why. These men equip their plants with honest instruments to safeguard their men and their investments and to guide the men toward efficiency. Recording instruments are vital to the all important objective—net profits."

THE indicating and recording of temperatures is not only important to the operator to check the course of an individual run, but also to duplicate conditions once determined as conducive to most efficient procedure.

The development and application of the temperature regulator in oil refineries and gasoline plants is an outgrowth of the necessity and demand for accurate and standardized plant procedure, in a day when strict competition and smaller margins of profit have made necessary strictest economy and highest efficiency in all methods and practices.

The importance of the automatic control of temperature is coming to be recognized throughout the refining industry and this recognition is attested to at present in the numerous and diversified installations of regulator equipment and the different types of automatic control devices available for practically every process where temperature is a factor and automatic regulation is practical.

In the manual control of temperature conditions through hand regulation of valves, the most experienced operator can compensate for changes in temperatures only when such changes have actually taken place and have shown themselves by readings on thermometers.

AUTOMATIC temperature regulators possessed with a seemingly innate quality so-called the sixth sense of industry, anticipate changing temperatures and compensate for them automatically.

The most successful temperature regulators on the market today represent the culmination of years of research and development towards the production of instruments comprising the essentials of ruggedness, accuracy and dependability, and the successful application and adaptability of these instruments to the different processes in connection with which they are recommended.

Automatic controls can be classified as self-acting, air operated, electric contact controls.

The self-acting regulator is so called from the fact that no outside motive force is required for its operation. This instrument comprises the tube system and the valve. The tube system consists of a connecting tubing at one end of which is the sensitive bulb member, with the opposite end connected to a set of diaphragms joined directly to the valve.

Through this valve, the heating medium flows to the apparatus under control. The tube system is partially filled with a liquid so that when heat is applied to the bulb, the vapor pressure set up in the system tends to expand the diaphragms which in turn control the movement of the valve.

From the nature of its operation, the self-acting regulator is naturally not adaptable to extremely close temperature regulation, and this factor naturally somewhat limits its application in refinery processes. However, it is extensively used in connection with crude oil heating plants, located on leases, where the application of other types of controls is not feasible and extremely accurate regulation is not so important.

THE air-operated temperature regulator is one of the leading types of controlling devices that has been developed and in many cases standardized upon in refinery process work.

This controller involves two all important units, one of which is the sensitive bulb member of the instrument, the other the air valve which controls the compressed air supply necessary for the operation of the diaphragm control valve. The sensitive bulb member of the instrument may be either a solid filled system filled with mercury under pressure or a hermetically sealed tube system partially filled with a volatile fluid, an instrument of this latter type being called the vapor tension actuated type.

With this instrument, when the bulb is subjected to an increase in temperature above the boiling point of the medium used in the tube system, a vapor pressure or tension is set up causing a capsular chamber in the instrument proper to expand and thus open the air valve which permits air to pass through the instrument to regulate the control valve in the cooling medium or heat medium supply line.

In the case of the mercury filled systems, the expansion or contraction of mercury under changing temperatures, operates a coil in the instrument proper, which correspondingly regulates the passage of compressed air through the instrument to operate the diaphragm or control valve.

In vapor tension actuated regulators, temperatures can be controlled to a maximum of 660 degrees Fahr., while with mercury actuated systems, this maximum is 1000 degrees Fahr.

STILL another type of air operated control involves the expansion stem type. This regulator consists of a sensitive member made of two dissimilar metals. A brass tube fastened to the instrument contains a non-expanding stem, one end of which is held in position in a so-called stem box, the other end of

*Taylor Instrument Companies.

which operates against an air port on the expansion or contraction of the expanding stem. When heat is applied to the regulator stem, the movement in respect to the air port controls the admission of compressed air which operates the diaphragm valve in the control line.

The success of air operated temperature controls is due in large measure to the characteristic action of the diaphragm valve. The action of this valve is an immediate response to changing temperature conditions around the bulb of the regulator. The position of the valve disk is regulated both by the amount of compressed air allowed to pass through the regulator to the diaphragm valve top, a spring action which normally holds the valve open, and the pressure of the medium in the control line.

In actual operation, a balance of conditions is maintained so that the diaphragm valve throttles. The slightest change in temperature in the apparatus under control, from any source whatsoever, will instantaneously change the opening in the diaphragm valve to compensate for the change in temperature. Through the throttling or breathing action of the control valve, a much smoother and more regular control can be accomplished than where the movement of the control valve is limited to a full open, full closed, or fixed intermediate position.

ONE of the last developments in the air operated type of regulator is that instrument known as the thermo-time regulator designed for controlling temperatures in relation to time. This instrument finds particular application in refinery processes where it is desired to control temperatures in accordance with a predetermined time and temperature schedule.

The temperature can be increased or decreased at a gradual or rapid rate, or a combination of both. Incorporated also in this instrument is a time device terminating the process at any time within the range specified.

The electric contact type of control is used to control motor operated valves, contactors or other electrically operated apparatus. This instrument is adaptable to the control of temperatures from minus 40 degrees to plus 1000 degrees Fahr. This instrument is operated by a liquid filled tube system. At one end of this is a sensitive bulb member, at the other end, a coil to which is attached a movable arm pivoted at one end and carrying an electric contact making surface at the free end. This common mechanism moves in the path of an arc and is operated by the so-called maximum and minimum contact surfaces.

The above instrument in refinery processes is applicable in connection with refrigerating processes, for controlling the flow of brine, starting or stopping compressors, etc.

For temperatures above 1000 degrees Fahr., the type of electric contact control in wide use is that operating on the pyrometer principle. This control is essentially a pyrometer consisting of the thermocouple and indicator and connecting wires. A special timing mechanism is provided in the indicator so as to raise the swinging pointer at definite intervals. When the pointer is raised, it makes contact on either the high or low connection, which contact in turn operates the heat supplying medium through proper relays, motor valves, or contactors.

THERE is hardly a process in the refining industry that operates on temperature and is adaptable to automatic regulation that cannot be controlled automatically by a selection of instruments from those described above. However, the selection of these instruments should be based on the thorough understanding of the make-up and details of the individual instruments in relationship to the particular process in connection with which it is to be applied.

While automatic control applied to various refinery processes is supposed to take care of variable conditions and fluctuations of temperature, the success of this accomplishment is largely possible only where care and consideration is exercised in the installation of the regulator equipment. For the success of any automatic control device, much is dependent on the smoothness and consistency of the operating condition and no automatic control should be condemned for apparent failure to do its part until the operator was sure that his own operating conditions are sufficiently smooth and consistent as to make the application of automatic control feasible.

In the selection of automatic control equipment, special attention should be given to the type of instrument selected, the type of connection used, the location of the sensitive bulb member of the regulator and the size of the control valve specified, for the correctness of these factors determines in large part the closeness, regularity and dependability of control that can be accomplished.

SINCE the refining of crude oil is fundamentally based on temperature conditions, the proper control of the temperature of distillation is highly important, both as a matter of conservation of fuel and labor and as an aid in the close separation of the various crude oil constituents, to produce maximum yields and consistent results.

In fire distillation processes, gas or oil fired stills, using one pipe burner, that is, a burner which induces its own air for combustion, are adaptable to automatic regulation. This holds true in the case of both the so-called batch and continuous processes.

The thermo-time temperature regulator will control temperatures in a batch still in accordance with a predetermined time and temperature schedule, or in other words, will control temperatures in relation to time. In batch distillation, the rates of temperature rise can be maintained constant or varied, dependent on the specifications as desired.

The single-duty temperature regulator will control fixed temperatures in continuous type stills by regulating the fuel supply to the burner by means of a diaphragm valve in the fuel supply line. For this purpose, the mercury actuated temperature regulator is widely used thoughout the industry. The peculiar characteristics of this instrument, the fact of its ruggedness of construction, that it will control temperatures to a maximum of 1000 degrees Fahr., that the same closeness of control can be obtained at any point throughout its range, make it one of the most satisfactory controls available for still temperature regulation. In actual operation today, mercury actuated regulators are controlling temperatures as high as 750 degrees Fahr. to a closeness of control of less than 10 degrees overall range.

IRREGULAR temperatures in steam stills are reflected both in the quantity of steam consumption, and the character of the recovered products. Close temperature regulation in steam stills results in a conservation of steam and uniformity in quality of distillate, whether this in rerun stills in refinery processes, or steam stills in natural gasoline plants.

In natural gasoline plant operations, a high still temperature will overload the knockout box and result in the production of high end point and possibly off-color gasoline. A low still temperature results in improper stripping of the oil with attendant reduction of plant output.

Automatic controls will maintain constant temperatures in steam stills by regulating the amount of steam through a diaphragm valve in the steam supply line. Many operators prefer the expansion stem type regulator for this purpose. Control here is also accomplished by the single-duty temperature regulator, and this type is many times preferred from the fact that the instrument proper can be located at a maximum distance of 75 feet from the point of application of the sensitive bulb member.

The double-duty temperature regulator will control temperatures in steam stills where both live and ex-

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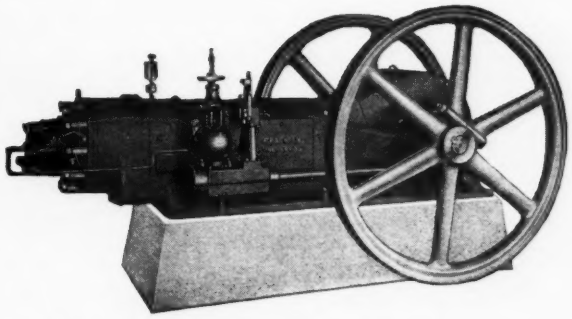
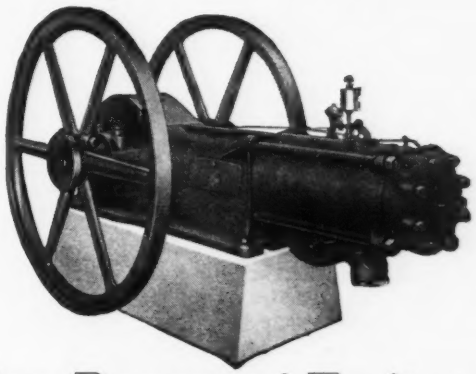


Oil Pumping Engine



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haust steam are used for heating. This regulator connected to two diaphragm valves, one in the exhaust and one in the live steam line, permits the necessary amount of exhaust steam to be used, and when heat from this source becomes insufficient, automatically opens the live steam line until the desired temperature has been reached.

IN NO phase of refinery plant operations has the success of air operated automatic controls been more amply demonstrated than in the application of these regulators to fractionating or bubble towers.

The successful operation of fractionating towers is dependent on close control of the temperatures of the vapors passing from the top of the tower to the condenser. A constant temperature in the outlet vapor line from the tower results in the production of a uniform grade of gasoline.

If the outlet vapor temperatures are high, the condensed gasoline will have a higher end point than desired, which will necessitate a redistillation of the product with consequent distillation loss, interference of plant routine and needless expenditure of time and energy. If tower temperatures are low, the gasoline yield will be low, which obviously means a reduction in plant output. Upon the closeness of tower temperature control depends the completeness of recovery of each light oil fraction.

In natural gasoline plants, constant temperatures in the tower or knock-out box are of the same essential importance as in fractionating towers in crude oil refining, for temperatures as here carried determine the color, endpoint and the gravity of the recovered gasoline. High temperatures at this point may mean an off-color product of higher end-point than desired, due possibly to some of the absorption oil being carried over.

A low knock-out box temperature would materially reduce plant output. Gasoline knocked down with the heavy oil fractions in the knock-out box, or dephlegmator, will in many cases, be ultimately returned to the main circuit of the absorption oil, possibly saturating it beyond its capacity for further absorption, and so causing the gasoline contained in the rich field gas to be rejected from the absorber through the denuded gas outlet.

THE accurate control of tower temperatures through hand regulation is difficult and impractical. Air operated automatic controls give the spontaneity of action and throttling of control valve which are conducive to efficient temperature regulation with the accruing benefits attendant thereon.

Single-duty temperature regulators are used extensively throughout the refining industry for automatically effecting tower temperature control. This regulator, in conjunction with a diaphragm valve in the cooling medium supply line, will automatically regulate the admission of the cooling medium to the tower in accordance with the temperature in the outlet vapor line.

The expansion stem type of regulator is also extensively used for tower temperature control, especially in natural gasoline plants. The fact, however, that the instrument proper is necessarily located immediately adjacent to the point of application of the sensitive bulb member, makes this instrument not as desirable as the single-duty regulator, which can be located at a distance as high as 75 feet from the bulb.

The success of automatic controls applied to towers is concretely evidenced in the fact that in many gasoline plants, these instruments have for years consistently and accurately held tower temperatures at the required point of maximum output, and in no instances has temperature varied sufficiently to permit the production of off-color gasoline.

IN THE sweating of paraffin wax, the nature of the operation and the character of the material being processed makes the element of temperature control extremely important. Temperature regulation here involves a corresponding control of two factors; one, the temperature of the oven itself, the other, the temperature of the water which circulates through the coils embedded in the wax cake.

An undue increase in the temperature of either the water or the room will melt out some of the desired product and in addition affect the wax cake to the extent that the final product will have a relatively high percentage of oil. This occurrence also represents a needless expenditure of steam.

An undue decrease in the temperature of sweating will retard the process, the outer or exposed surfaces of the slack wax cake in the wax cake pans are chilled, thus arresting the flow of oil from the cake and upsetting the balance that would be possible if uniform temperatures were assured.

In the manual control of the wax sweating process, considered in the light of the ordinary standards for determining proper conditions and maintenance of temperatures, human weaknesses and inconsistencies, naturally give rise to imperfections in control.

Automatic air operated control intelligently applied to wax sweaters will control both room and water temperatures in definite or variable relationship in accordance with a predetermined time and temperature schedule. This accomplishment, through the maintenance of proper temperature from representative conditions, and elimination of the human element will effect an economy over manually operated processes reflected possibly in increased yield, higher quality product or conservation of time, steam and labor. This is in part possible by the type of control, where the valve action is immediately responsive to any changing temperature around the sensitive member of the regulator and throttles to compensate for this change.

The successful application of controls to wax sweaters is not simply the application of a temperature regulator to the control of a heating medium, but it is an engineering problem in itself. The successful automatic control successfully applied to wax sweaters can be worked out only by one thoroughly acquainted with the peculiarities of construction and operation of wax sweaters and the different types of regulator equipment in their relationship to wax sweater control requirement.

New Maps for Oklahoma and Texas

WASHINGTON, Sept. 19.—New editions of oil and gas field maps of Oklahoma and Texas have been published by the U. S. Geological Survey. Names and locations of new pools and the location of many new wildcat wells are shown on the maps. The scale is sufficiently large so that new developments can be recorded, according to the survey. The maps are in colors.

First-Aid Contest at Pittsburgh

WASHINGTON. — Thirteen states were represented at the sixth international first-aid and mine-rescue contest held by the U. S. Bureau of Mines at Pittsburgh, Aug. 30 and 31, and Sept. 1. These states were to furnish 49 first-aid teams and 19 mine-rescue teams representing coal and metal mines, quarries and oil producing operations.

Prizes were to be awarded to the most efficient teams. Events were judged by doctors and expert laymen skilled in first-aid training and conversant with the Bureau of Mines first-aid standards.

KANSAS CITY, Mo.—Butler Mfg. Co. is making pipe that can be used as conduit, double well casing or in other ways, in diameters of 16 inches to 6 feet. The pipe is made of blue annealed copper steel or tank plates and machinery has been installed to handle and electrically weld this pipe. The pipe can be had in any length or gage.

Some Factors Concerning Petroleum Fractionation

By W. A. Peters, Jr.

THE principles of fractionation have been thoroughly discussed at recent meetings of petroleum sections of various technical societies and in the journals, and it is evident that the importance of this subject to the petroleum refiner is receiving justified attention. The value of effective fractionating apparatus is generally recognized by the more progressive refiners.

The principles of the design of various types of towers and the kind of results that can be obtained from them are also well described in recent articles. Although many types of towers have been used, it appears that the bubble tower is rapidly becoming the standard equipment for petroleum work. Nevertheless, a few towers of other types are found and we still hear arguments, for example, as to the comparative efficiency of the packed tower and the bubble tower.

The reason that this discussion has not been settled sooner may be that there is still some confusion as to the meaning of the term "efficiency" as applied to fractionating towers.—It is really meaningless to compare the so-called "efficiency" of two types of towers. Any tower which acts as a counter current scrubber can be built to give the same separation for the same fuel consumption as any other tower. One tower may be five times as high as the other and it might be said that the lowest tower was the most efficient per foot of height. However, the lower tower might be much larger in diameter so that the higher tower would be more efficient per cubic foot of volume.

Neither of these points interests us directly; we only want to know which tower of two that do exactly the same work will cost less and we are interested not only in the first cost, but in all the costs that may be charged against the tower, such as structure, upkeep, replacements and even the possible extra cost of pumping reflux to an additional height. By such means it can be determined what type of tower is the most economical.

THOROUGH tests on small packed towers indicated that certain types of packed towers might be more economical than bubble towers, but when these packings were tested on a larger scale the results were generally not good, due to irregularity of distribution of the vapor and liquid, and the bubble tower remained the standard in those industries where sharp separations were demanded.

It should not be inferred from this that the bubble tower is universally more economical than any other type. The packed tower is still more economical for handling very corrosive materials, such as mixtures of nitric and sulfuric acids and water.

The discovery of a cheap alloy which will resist these acids may alter this condition and lead to the introduction of bubble towers in acid plants. It was proved long ago that the bubble tower was the most economical in the alcohol industry and in many others where comparatively non-corrosive liquids are handled.

It is rapidly being proved that the bubble tower is more economical, i.e. has a lower ultimate cost than any other type of tower for petroleum refining. The reason that this was not more generally admitted before is that formerly, sharply cut petroleum products were not required, nor was it customary to analyze the products as carefully as is now done. We can now tell within half a per cent how much material of a given end boiling point there is in a given crude and decide for instance how much is to be put into the gasoline and how much into the kerosene.

The laboratory fractionating apparatus used for this exact analysis is shown in figure 1. This apparatus is used for determining the boiling point curve up to about 600 degrees Fahr. Above this point vacuum must be used. Such an apparatus eliminates much of the uncertainty regarding possible yields in petroleum refining and makes it possible to operate with the same close control that has long been required in other highly competitive chemical industries.

W. A. PETERS Jr.

Mr. Peters is a graduate of Yale University and the California School of Mines. He has spent substantially all his time since 1915 *on experimental and practical distillation in the petroleum refining and other fields. He is recognized as one of the foremost authorities in this line. Mr. Peters is in active charge of petroleum refinery equipment work with E. B. Badger & Sons Co.*

THE general principles of the design of the bubble tower are well known and it is not necessary to discuss here the importance of such factors as plate spacing, depth of seal, etc. as affecting the operation and the capacity of a tower. A great deal of work has been done to determine the best arrangement of bubble caps, down pipes, etc. to obtain the maximum capacity and the sharpest separation with the fewest number of plates under many different conditions of operation, both at atmospheric pressure and under high pressure and high vacuum.

It is not sufficient that the bubbles from a single test cap should distribute properly, but the distribution of bubbles over a large plate must be

even. Figure 2 shows a 5-foot diameter plate working at moderate capacity and Figure 3 shows the same plate at high capacity. It will be noted that especially at high capacity the surface is an even mass of foam; it is impossible to tell where the caps are. These results were obtained with circular caps.

Caps of other shapes such as rectangular caps and other caps with parallel sides were tried and in no case were the results as good as with the circular caps.

It will also be noted that there is a baffle dividing the plate and that the downpipe crosses through this baffle. The liquid has to travel through a longer, narrower path than if it entered on one side of the plate and discharged on the other. Furthermore, the liquid is flowing in the same direction on all plates so that the contact of vapor and liquid on successive plates is substantially counter-current.

This is not the case with the ordinary type of plate or the plate with multiple downpipes on which the liquid flows in one direction on one plate and the opposite direction at similar points on the plates above and below. The arrangement of plate shown in Figure 2 on which several patent applications are pending, gives especially good results when the flow of liquid reflux is small compared to the vapors.

THIS type of plate made of steel with steel baffle has been used for alcohol work, but it has worked out especially well for petroleum work. Towers which have been in use for several years have been inspected and corrosion of the plates found to be hardly appreciable even with a corrosive crude and where the cast iron caps have corroded sufficiently to form a scale in the slots.

In order to take care of any possible scaling of the caps the towers are built with a large manhole at each plate. It was occasionally noted that a plate directly below a reflux cooling coil would corrode where the cold condensate dripped onto it and this corrosion was the same whether the plate was made of steel or cast iron. In such cases, however, the cooling coil in the top of the tower corroded very rapidly. These cooling coils have generally been discarded and other arrangements made for furnishing reflux to the top of the tower.

Equally as important as the details of design of the tower is the arrangement of towers in a system to give the desired cuts for smallest investment in equipment and the lowest fuel consumption. Here again it is a question of economy and not of obtaining the sharpest possible cuts, in fact it is not economical to cut too sharply and as has been pointed out before there is a tendency to go too far in this direction.

GAPS between the Engler curves of successive cuts may be a sign of uneconomical operation. The sharpness of cuts will depend on the arrangement of the apparatus and on the relative values of the product and each case will have to be determined separately. Two examples will be given for illustration, first the separation of a kerosene cut drawn from the side of a large column where a small auxiliary column is provided for stripping kerosene with steam and second, the separation between gasoline and kerosene in a battery of shell stills with columns.

The Engler curves of the products obtained in the first case are shown in Figure 4. Curve 1 shows approximately the type of gasoline that would be obtained and curves 2, 3, 4 and 5 show the kerosene obtained with various amounts of steam in the stripping column. Curve 2 shows product when using no steam and curve 3 when using a very small amount of steam.

To obtain the product 5 requires the use of many times as much steam as is required to make the product 3. When all the factors entering into the situation are considered it is found that the additional steam required to make product 5 is not justified by the increased yield of gasoline obtained. It is seen that a comparatively small amount of steam

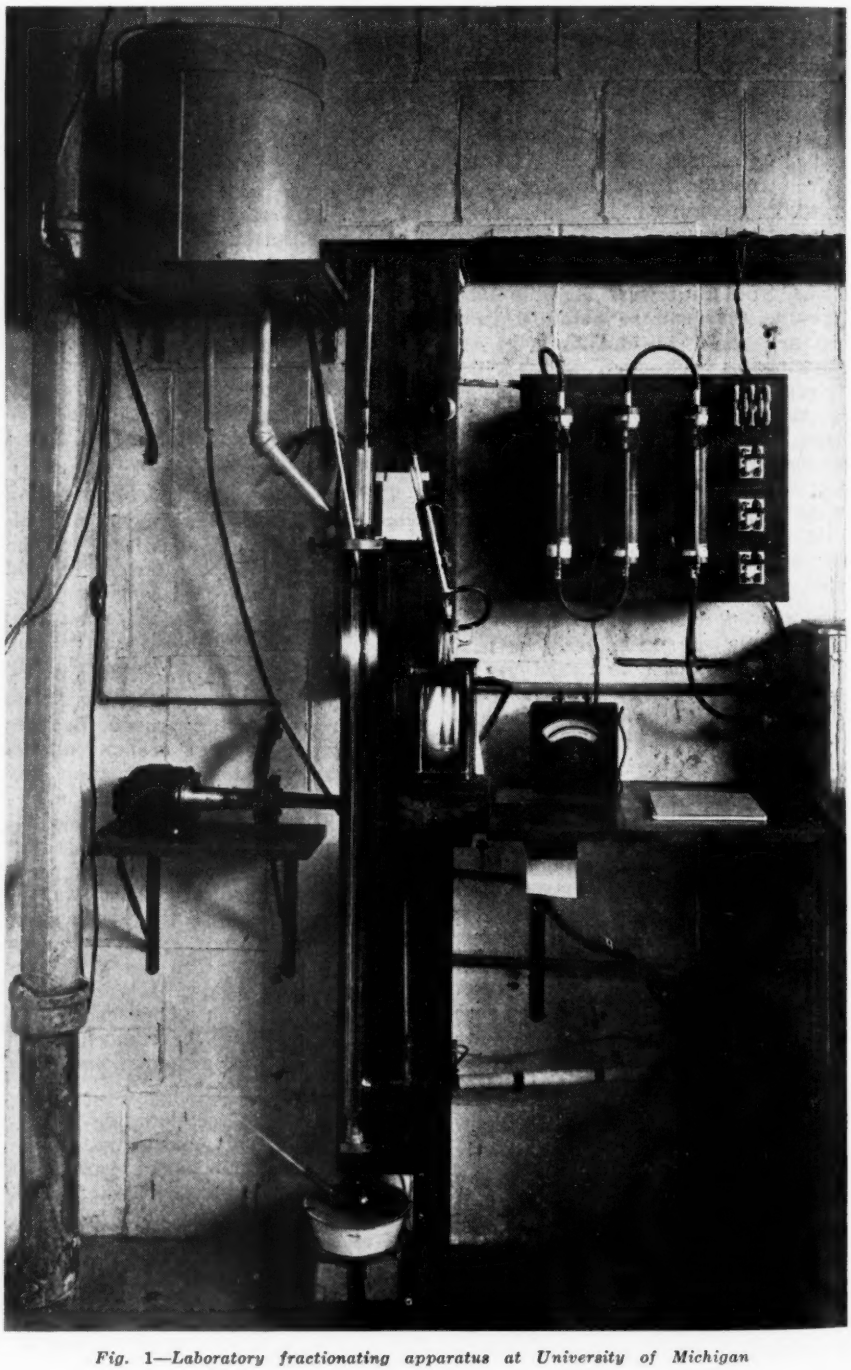

Fig. 1—Laboratory fractionating apparatus at University of Michigan

Fig. 2— A 5-foot bubble tower plate working at moderate capacity

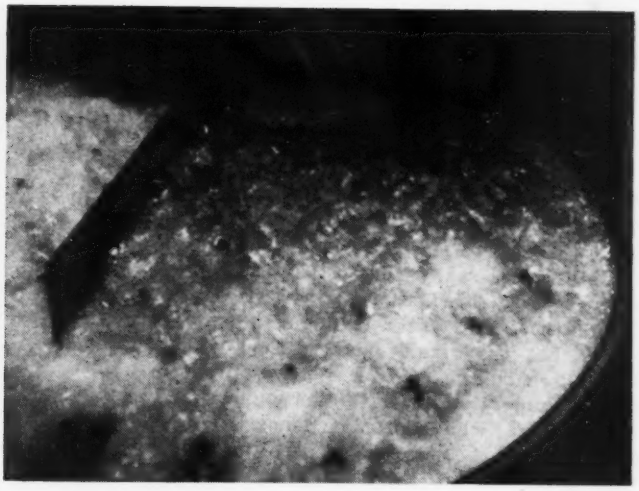

Fig. 3—The same plate working at high capacity

makes a large difference in the initial boiling point of the kerosene and increasing amounts of steam make relatively less difference.

It is interesting to note that if the stripping were done by reboiling the kerosene with heat furnished to the base of the stripper, it would be found that a small amount of heat would make comparatively little difference in the initial boiling point of the kerosene and that increasing amounts of heat would make a much greater difference, so that the choice of the most economical means of stripping will depend, among other things, on the sharpness of the separation desired.

The second case to be considered is a shell still battery with and without fractioning towers. Figure 5 shows the kind of results obtained on the third and fourth stills of a battery with no towers. No definite products are made and the whole distillate must be rerun. Figure 6 shows the type of products after the battery was equipped with bubble towers. Using the same ratio of heat exchange, the fuel cost with the bubble towers would be about $1.55 per 1000 barrels more than without the bubble towers, but the cost of rerunning products obtained without towers far more than offsets the additional cost of operation of battery with towers.

ONE of the most complicated problems to be determined in connection with tube still operation is the method of heating and vaporizing the crude. A careful comparison of the results of vaporizing a sample of crude by different methods has been made by Leslie and Good.*

Two methods of vaporization in particular, single flash and successive flash, were studied. By single flash vaporization is meant the method of bringing the whole sample of crude to a given temperature and allowing vaporization to take place at that temperature; all the vapors being maintained in intimate contact with residue until vaporization is complete. Substantially single flash vaporization takes place in the vaporizer of a pipe still unit when the crude is heated and the whole crude runs to the vaporizer. If the vaporizer contains stripping plates or if steam is added, the vaporization will not be strictly single flash, but will approach it more or less closely.

By successive flash vaporization is meant the method by which the crude is vaporized in several stages, vapor being removed at each stage and the bottoms reheated for further vaporization. It is obvious that at a given temperature more distillate would be produced by single than by successive flash vaporization, since the

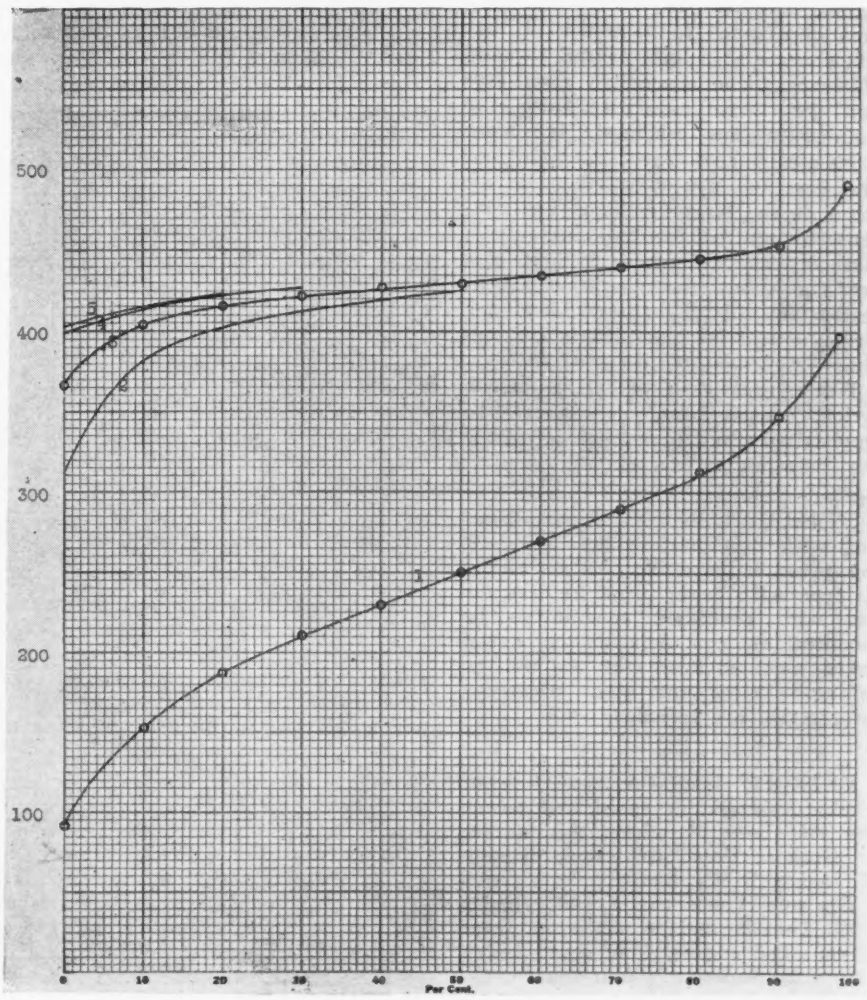

Fig. 4

*J. Ind. Eng. Chem., 19, 453-60, (1927).

lighter material would act as a gas and carry over heavier products just as in steam distillation.

It is not so obvious that the yield of material of any given end point might be greater by single than by successive flash distillation and yet this was found to be the case. It was also found that the gross heat required to produce a given amount of distillate was less by single than by successive flash distillation.

From these two facts it might be argued that the single flash method would be the most economical way to distill a crude. However, a thorough study of the whole problem shows that this is not the case, where a large percentage of the crude is to be taken off as a distillate. The gross heat required by single flash is less, but much of this heat is not recoverable since it must be taken out of the system at a low temperature level.

It is assumed in these comparisons that the stills in either case have the same efficiency. Actually the difference in efficiency of different types of stills will make a greater difference in fuel consumption than any other point in the design, provided a reasonable amount of heat is recovered by exchangers. It is, therefore, of first importance to have a still that will operate at a high overall thermal efficiency. The successive flash system for large capacities, also for running to low residues, is more economical from the standpoint of first cost and upkeep of plant on account of the larger columns and condensers required for the single flash method. The differences in first cost are not great for plants of 5000-barrel per day capacity, but for larger capacities the differences become appreciable.

While first cost of plant merits serious consideration, it should be emphasized that first cost is rarely the determining factor.

SYRACUSE, N. Y.—Crouse-Hinds Co., with headquarters here, has off the press bulletin No. 93 describing its type ARB vapor proof fixtures for use with concealed conduit to be mounted on condulets or on outlet boxes, mounted flush with the well or ceiling. Prices and other necessary information are included.

DETROIT, Mich.—A new line of trucks designed for speed and power has just been placed on the market by Graham Bros., the truck division of Dodge Bros., Inc.

The new truck has a six cylinder 2-ton chassis and is made in three types. The engine, four speed heavy duty transmission, four-wheel hydraulic brakes and low price are described by the company as features of the new truck.

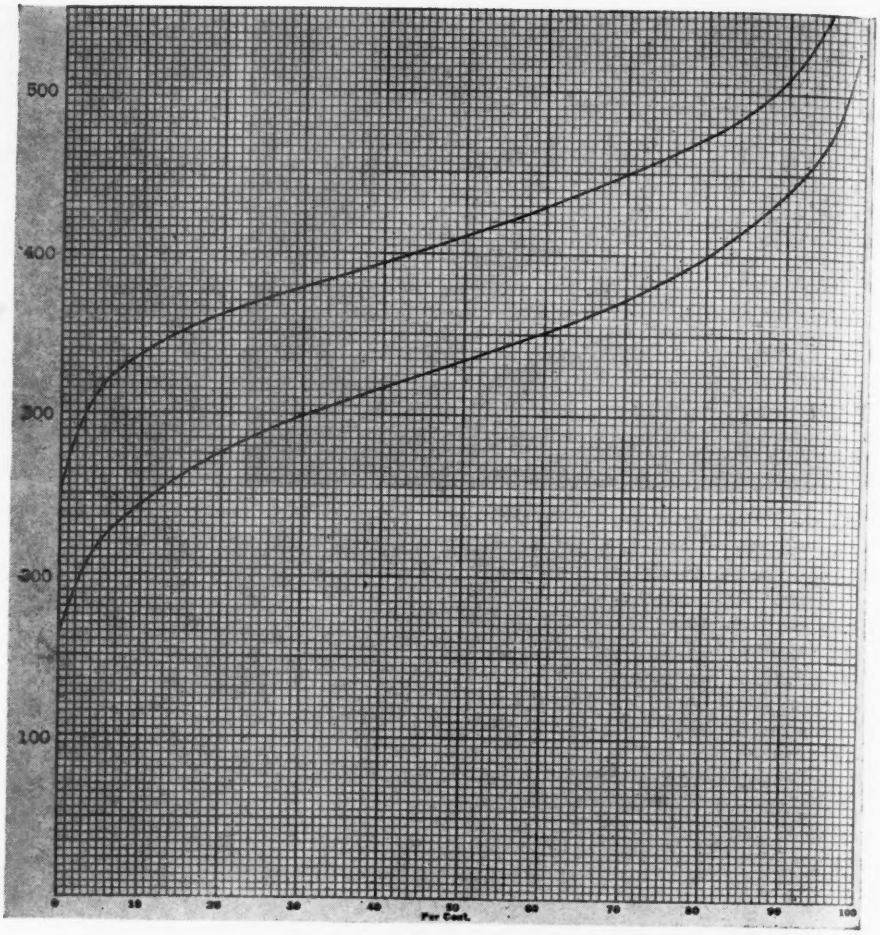

Fig. 5—Continuous battery, no towers

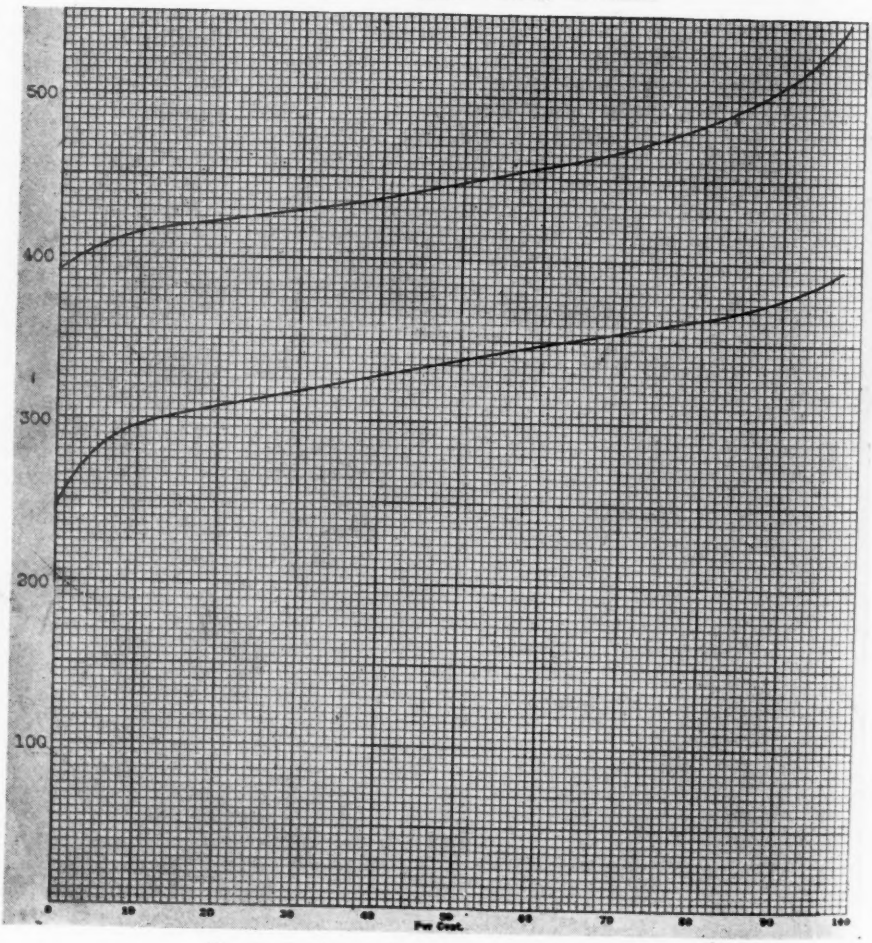

Fig. 6—Continuous battery with bubble towers

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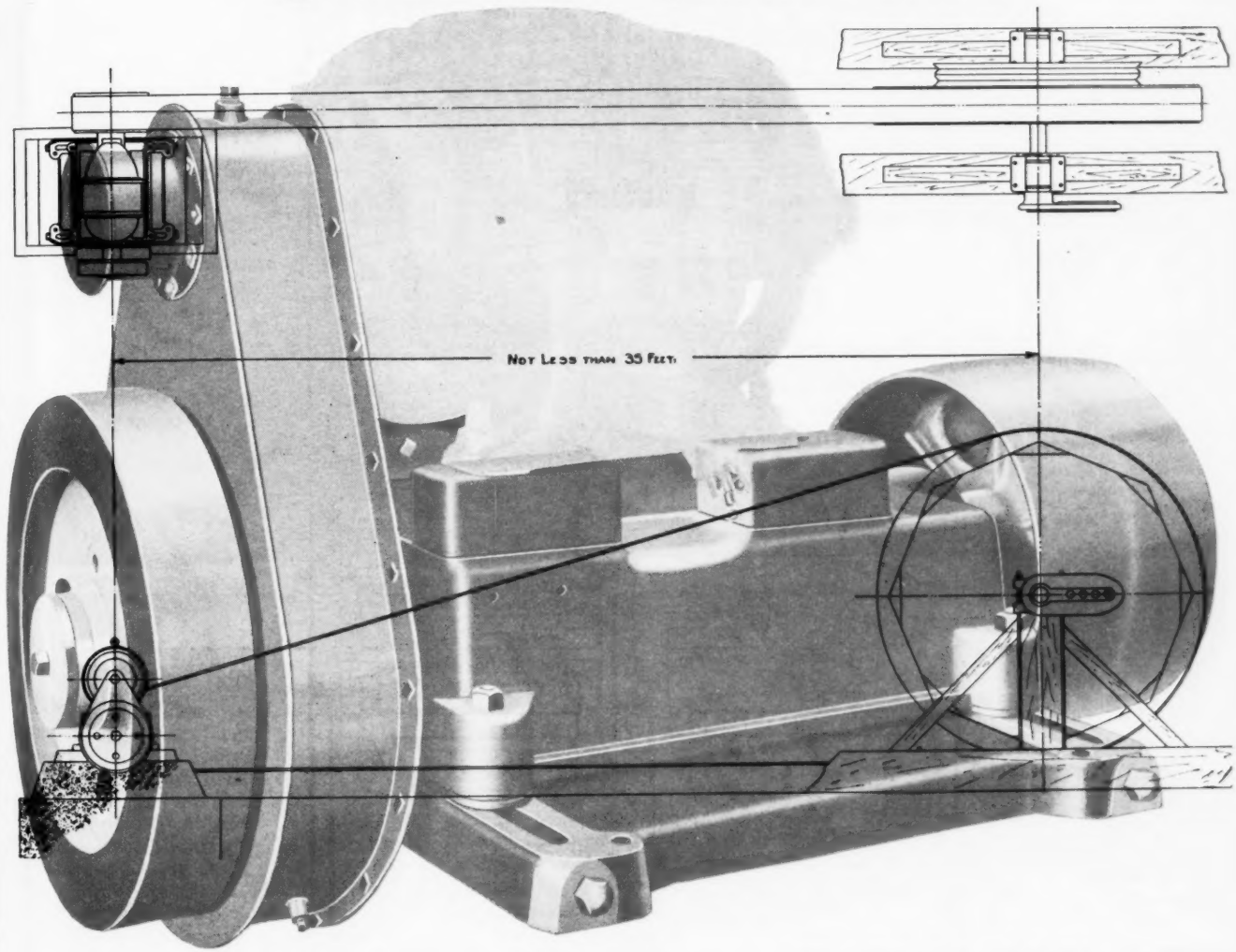

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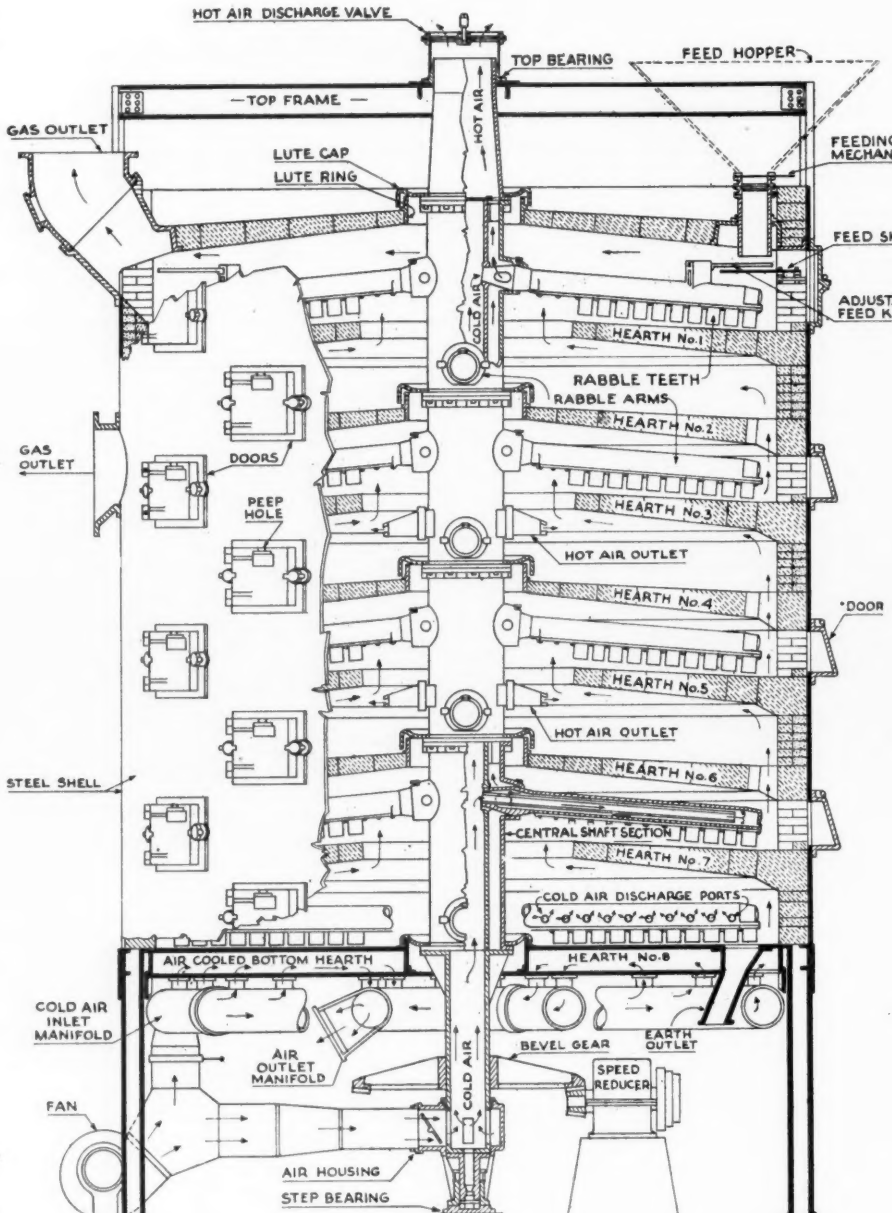

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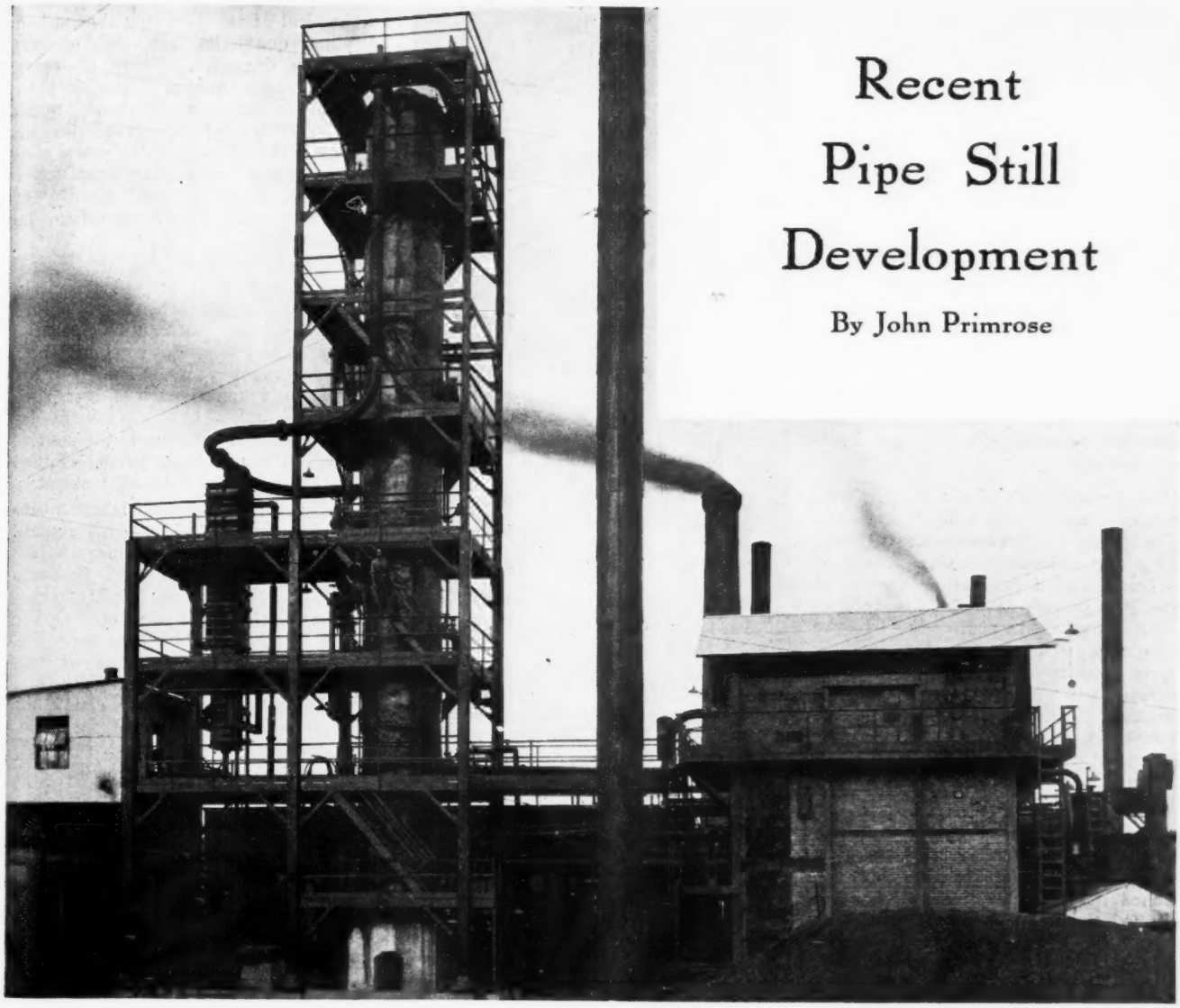
Recent Pipe Still Development

By John Primrose



Tube still and fractionating tower in Pennsylvania field runing to cylinder stock bottoms.

THE art of refining petroleum has developed very rapidly during the last few years in the direction of securing larger yields of better products at reduced cost. One of the outstanding features of this development is the more extensive use of the pipe or tube still as it is now perhaps more correctly called. Many installations of tube still, in combination with fractionating columns and liquid and vapor heat exchangers, are in constant service for all sorts of refining processes.

The performance of these units over a period of years has demonstrated beyond all question the soundness of the original conception and the practicability of the design and construction.

The improvement, resulting from the operation of such distilling units, is due largely to heating the oil to the high temperature required to evaporate the fractions that boil at the higher temperatures and supplying the latent heat of evaporation at these high temperatures without destroying any of the oil by over-heating.

It is possible to supply the requisite heat in this manner in tube stills, which therefore are essential to the successful operation of such units. The composite oil vapor thus produced is passed through a column and fractionated into sweet commercial products to boiling point specifications, entirely eliminating rerunning, and greatly reducing subsequent treating operations.

A LARGE part of the heat required in the distilling operation is recovered by the vapor and liquid heat exchanger, and used in the preliminary heating of the charge to the tube still, greatly reducing the fuel consumption of the still. Operating in this way, yields of light product are obtained in excess of those indicated by the standard laboratory Engler distillations and equal to those shown by the Hempel column, due to the absence of detrimental cracking because of effective heating, without overheating, and efficient fractionation in the column.

The strongest evidence of this is the improved yield of the more valuable highly viscous oils, which crack easily, and are the most difficult to fractionate.

Such oils are now produced continuously from tube still distilling units with a fuel and steam consumption much less than required to reduce these oils to viscosity and flash in shell stills, and in much shorter time. The steam consumption should not be more than 10 to 15 pounds per barrel, as compared with several times this amount in shell stills.

This saving of steam is an important item in reducing refining costs and can be taken full advantage of by using the exhaust steam from the charging pump of the tube still, which, when superheated in a section of the tube still, is sufficient to run most crudes to a 5 per cent bottom. These results can only be obtained when the heat required in the process is supplied to and absorbed by the

oil uniformly and at a rate which will not overheat or break down the delicate molecular structure of the material being treated.

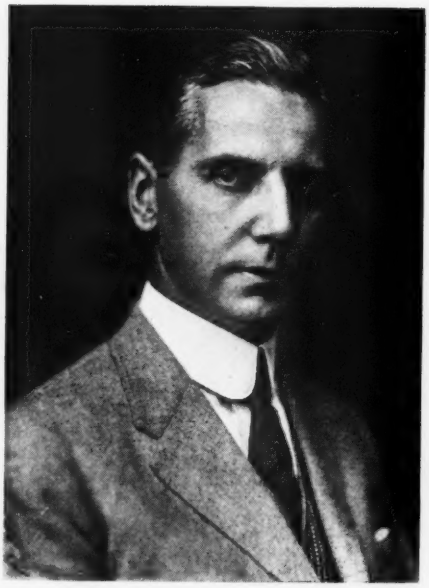
THIS requirement necessitates the most careful design and construction and a thorough knowledge of the principles involved. The experience gained during recent years, however, has made it possible to produce apparatus which will unerringly accomplish these results. Evidently it is of prime importance that all of the oil is heated to the maximum temperature required and none of it heated to a higher temperature. A very definite and positive control of the oil and of the heating apparatus is therefore necessary during the heating operation.

The development of the modern tube still has made it possible to accomplish these requirements most effectively and efficiently. The stream of oil being heated in passing through a tube still travels at a definite rate of speed, controlled positively by the charging pumps, gradually increasing in velocity as the hotter tubes of the still are reached, because of the increased volume of the oil, due to the increase in temperature and the formation of vapor bubbles in the oil stream.

These bubbles increase in size as the tube still outlet is approached, due to the reduction of head pressure so that the greatest velocity is reached at the tube still outlet after passing through the hottest tubes. A high velocity is necessary, not only to insure a mixing flow and consequent uniform heating of the oil stream, but also to insure the absorption of heat in the shortest possible time of contact with the heating surface if cracking of the oil is to be avoided.

IT HAS been conclusively demonstrated that oil, particularly the heavier fractions, if kept at temperatures considerably below the temperature usual for commercial cracking, will suffer sufficient molecular change to greatly reduce the yields of the more viscous material or increase the difficulty of treating the lighter products to stabilize color. Therefore, the purpose for which the tube still is to be used must be carefully considered in the design and proportions.

If the tube still is to be used to recover the products contained in the original crude, it is essential to accomplish the heating as rapidly as possible; but, on the other hand, if the tube still is to function as the heating element of a cracking process where a degree of molecular change is the result desired, then it is of importance to provide for a period of contact with the heating surface of sufficient length to accomplish the degree of reaction desirable in the heating element.



JOHN PRIMROSE

Mr. Primrose was graduated from McGill University in 1895 *with the degree of B. A. Sc. In the same year he entered the engineering department of Henry R. Worthington where he remained until* 1901. *He became chief engineer of the Power Specialty Co. in* 1901, *holding that position until* 1920, *when he took full charge of all oil refinery work for the company. He is now vice president of the Power Specialty Co.*

Too long a contact with surface at too high a temperature, will result in formation of much carbon and fixed gas without materially increasing the yield of condensable light vapor.

Tube stills were originally used in cracking processes largely because the charge had to be heated under pressure. It was soon found possible to first heat the oil to a temperature where the reaction becomes active, afterwards holding the oil in contact with heating surface, having a temperature but little above that of the oil flowing through it until the degree of reaction desired in the heating element was realized.

Many tube stills are in successful operation as pressure stills for cracking, and many others, are in equally successful operation where it is essential to avoid cracking. The ability to meet such divergent requirements demonstrates conclusively the adaptability of the tube still and the control it is possible to achieve by careful design and construction.

MUCH less skill is necessary to operate a tube still than is required to produce results from shell stills. Often the success of shell still operation depends to such an extent on the skill of the operator that, when he slips, quantities of valuable material are degraded. Most of these operators have gained their skill by practical experience, without much real knowledge of the principles involved in the operation they are conducting. Any unusual circumstance or change in conditions, outside of their experience, would therefore be embarrassing.

The condition governing the operation of a tube still can be definitely determined by the laboratory before starting and the still can be operated to produce the temperature found best suited for the purpose. The operator requires only sufficient intelligence to control his pump to give the predetermined throughput and to control his fire to maintain a predetermined temperature at the tube still outlet.

Both throughput and temperature are under simple and positive control and can be varied from time to time if laboratory checks on the products indicate a slight change in temperature or throughput desirable. The volume of oil contained in a tube still is so small that adjustments of this sort can be made very rapidly and any change in operating conditions are immediately reflected in the products.

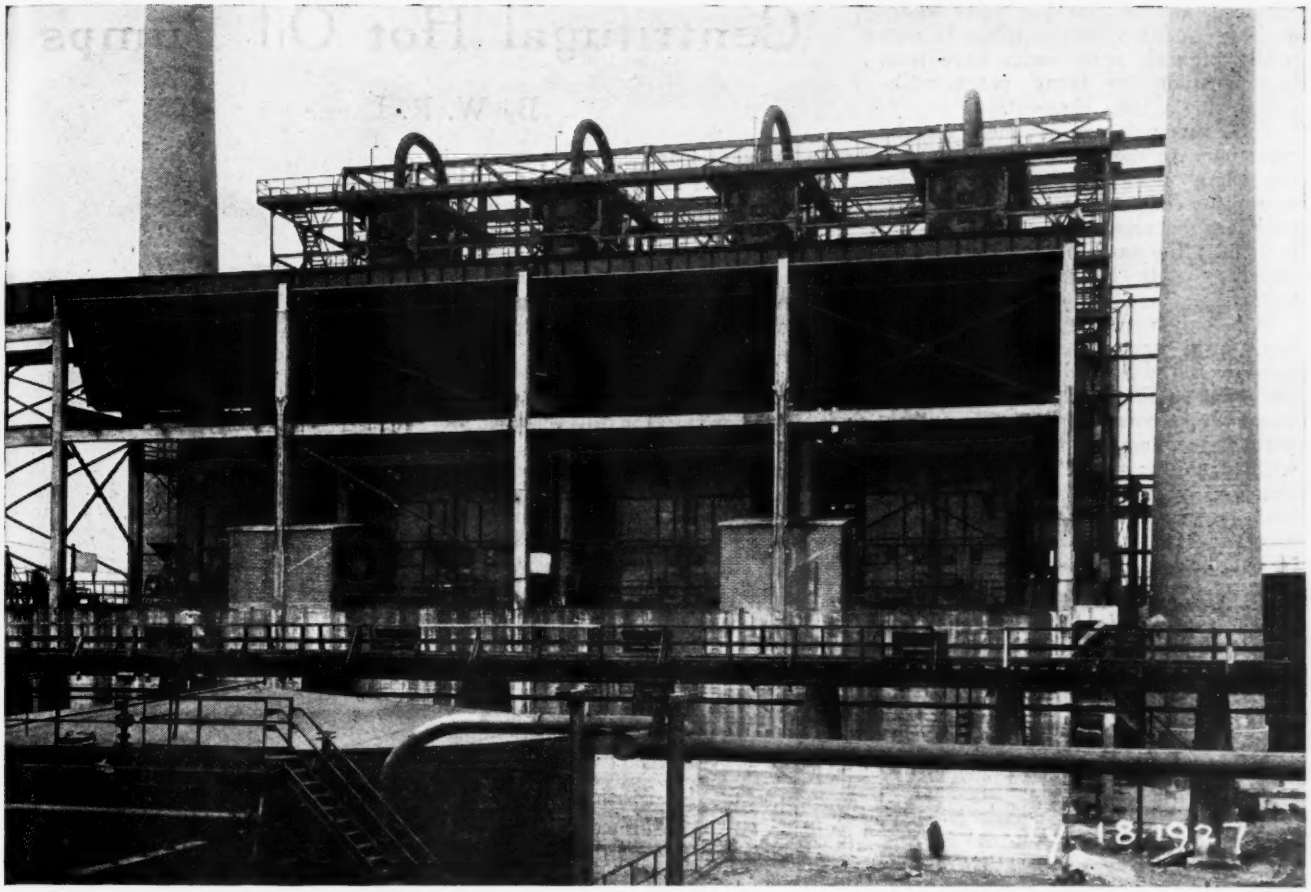
No particular skill or knowledge of oil refining on the part of the operator of a tube still is necessary. It is only necessary that such an operator carry out very simple and definite instructions.

TUBE still construction very closely resembles in appearance that of the ordinary water tube steam boiler and the operation of each is closely similar. The tube still possesses all of the advantages of the water tube boiler when compared with horizontal return tubular construction, with the added advantage that the circulation is positively controlled by the feed pump and the absence of a water level which requires constant watchfulness.

In other respects the operations are closely similar. The thermal efficiency of the modern tube still compares very favorably with the best steam boiler practice. Solid, liquid, or gaseous fuels are used and burned in combustion chambers of sufficient volume to insure complete combustion with minimum excess air.

Excessive furnace temperatures are avoided by exposing heating surface directly to the fire but located so as to be out of the path of furnace gas. Surface thus located absorbs heat by radiation and cools the furnace without overheating. The proper furnace volume and extent of radiant heat absorbing surface are governed by the quantity of fuel burned and can be definitely determined.

The furnace gases, before reaching the main flue, pass over a bank of heating surface, so arranged that the



Four tube stills installed at the Point Breeze refinery of the Atlantic Refining Co. There are a total of 29 tubular heaters in operation in the several refineries of this company.

flow of oil through the tubes of the heating surface is counter-current to the flow of furnace gases passing over the outside of the tubes. In this way, the furnace gases just before entering the flue, are in contact with the entering oil at the lowest temperature, cooling the furnace gases to the greatest extent possible by means of the oil flowing through the tubes.

In some cases the temperature of the oil entering the still is so high that the furnace gases enter the flue at 700 degrees Fahr. and above. In such cases air preheaters are employed and the air supplied to the furnace is heated by the heat recovered from the hot flue gas which can be cooled in this way to 300 or 350 degrees Fahr., resulting in a thermal efficiency of the tube still and air preheater of 85 per cent or more. The economic values, however, of the air heater and installation, depends entirely on the values of the fuel available.

IN MANY cases, the cost of fuel is not sufficient to warrant the increased investment, operating charges and maintenance, and it is better economy to operate at lower thermal efficiency without the air preheater.

An important advantage of the tube still construction is the ease with which the heating surface can be cleaned both inside and out. In order to thoroughly clean shell stills, it is often necessary to cool off the furnace and shell sufficiently to permit of opening and entering the shell and removing the accumulated coke or silt by hand.

This is a lengthy proceeding, requiring the still to be out of commission for long periods. The consequent loss of production, combined with labor cost, results in a considerable expense item. All of the tubes of a tube still are readily accessible for cleaning inside and out from outside the setting, and consequently it is not necessary to cool off the furnace or setting to thoroughly clean the still.

THE outside of the tubes are all readily visible when the still is in commission and soot or dust is easily removed by a steam or air jet mechanically operated or manipulated by hand. It is only necessary to shut off the fire and empty the still when the inside of the tubes become so foul that the transfer of heat to the oil is materially interrupted.

When this happens, the fire is shut off, the small quantity of oil contained in the tubes drained and the still steamed out with very little loss of time or material. Hand hole plugs are then removed from openings opposite the end of each tube, easily accessible from outside through doors provided in the sides of the setting, and mechanically operated tube cleaners are run through the tubes. When this is finished, the hand hole plugs are replaced, the still recharged and put into commission again in a few hours time, with a minimum loss of time and labor cost.

THE need of cleaning the inside of the tubes of a tube still is determined by the service it performs. Many tube stills running on crude are regularly in operation for three to four months without shutting down, and when down, are cleaned and on stream again in six to eight hours. Tube stills used with some cracking processes, when it is necessary to produce some coke in the tubes, are out of commission more frequently, the time on stream being determined by the nature of the process, but invariably the length of time off stream for cleaning is determined by the time required to remove coke from the balance of the equipment and not by the tube still.

Complete control and visibility of the outside of the heating surface while in operation and the ease with which thorough cleaning can be accomplished, very logically results in extremely low cost of maintenance. The conditions of operation dictated by the service demanded of the still, determine the amount of maintenance

required, and on cracking units where coke is produced in the tubes is naturally highest, crude units have been in operation for many years without a single tube renewal.

Tube renewals are confined, for the most part, to the radiant elements and are easily made, without serious interruption of service, with considerably less disturbance of operation than is usually the case in replacing a ruptured tube in a water tube steam boiler.

It is only necessary to shut off the fire, drain and steam out the still, remove the damaged tube, or tubes, and replace them with others, all of which is accomplished from outside without cooling of the setting, and with a minimum of effort and lost time. This compares very favorable with loss in time, material and labor necessary to repair a bulge or blister in the bottom sheet of a shell still.

THE maintenance of the settings of tube stills is also comparatively low because the brick work of the settings is securely bonded and supported independently of the heating surface of the still. Ample provision for expansion relieves the brick setting of strains produced by expansion and contraction of the heating surface of the still which is in no way dependent on the brick work of the setting for support. The temperature of the furnace is of necessity limited to avoid overheating the oil or the heating surface, and consequently a furnace lining built with a good grade of fire brick will last indefinitely.

It is not, perhaps, generally recognized, but the truth is that a distilling unit of tube still and single tower type possesses great flexibility, and by simple adjustment of controls, can be adapted to meet a wide range of requirements. A tube still and single tower installation has been used to top gasoline only from 11,000 barrels per day of Mid-Continent crude, the remaining bottoms going to cracking units. Later on, this same unit was used to recover light and heavy gasoline, kerosene, gas oil and fuel oil bottoms, and during this operation, a sizable throughput of pressure distillate was re-run as well. This same outfit has also been successfully used to run Mid-Continent crude to cylinder stock bottoms, taking overhead gasoline, kerosene, gas oil, pressable wax distillate and a wax slop stream with a throughput between 5000 and 5500 barrels per day.

No effort was made to provide for taking off a greater number of streams, but it would have been quite possible to have provided for splitting any one or all of the products made into closer boiling point fractions.

It is doubtful if a continuous battery of shell stills possesses equal flexibility, particularly as the tube still unit produces sharp cuts exactly to boiling point specifications, and at the same time cylinder stock to viscosity and flash without re-running.

Centrifugal Hot Oil Pumps

By W. R. Layne

THE centrifugal hot oil pump is one of the most highly specialized pieces of pumping equipment in use at the present time. By "hot oil" is meant oil at temperature above 550 degrees Fahr. and usually from 725 degrees to 850 degrees Fahr.—temperature far above the flash point of the oil being pumped. These temperatures are encountered in most of the cracking processes and the pumps are used for forcing the oil through the heating element.

In the early types of cracking stills, circulation of the oil through the heating element was obtained by the so-called thermo-syphon principle, probably merely an application of steam boiler practice to "oil boiling." It was soon evident that accelerated circulation would yield increased distillation rates and would, in addition decrease the rate of carbon deposit in the heating tubes. Both of these features were of great importance. In the case of one cracking process that was in general use and was already soundly established on a commercial basis, the application of the centrifugal hot oil pump resulted in an increase of throughput amounting to 100 per cent.

As early as 1917, it became evident that more circulation was desirable in oil cracking, and the still operators began to search for a pump suitable for this purpose. Here was an entirely new pumping problem with many complications introduced, due to the high temperature, and high pressure. Safety of operation was the first consideration. It was soon recognized that none of the then existing types of pumps were suitable for this service. The old-fashioned cast iron pumps, with simple, shallow stuffing boxes, and weak casing joints, not only were inefficient and unreliable, but were a positive menace to the lives of the operators.

THE first highly specialized pump for this purpose to make its appearance, was of the reciprocating type. This was quite natural when we remember the great priority of development of the reciprocating pump over that of the centrifugal. To most minds the word pump carried the idea of pistons, cylinders and valves, rather than any suggestion of the smoothly rotating impeller of the centrifugal pump.

These first hot oil pumps were, therefore, of the reciprocating type, and more particularly were of that class now known as "surge pumps." In the smaller capacities, with which the first trials were made, these pumps worked very much better than anything that had been used before. After a trial of one or two small units, one of the large oil refining companies in California decided to build a battery of some 15 large pumps of this type. These pumps were completed and set to work handling oil at 825 degrees Fahr. They gave considerable trouble.

The possibilities of the centrifugal pump had been discussed. The weight of opinion seemed to be against it, and it was only under the pressure of dire necessity that the men in authority finally consented to its trial. With much misgiving it was decided to

Mr. Layne, who has been for the past three years in charge of the oil pump division of Byron-Jackson Pump Manufacturing Co., claims the distinction of being the designer and builder of the first centrifugal hot oil pump for handling of oil up to 850 degrees F. The first of these pumps was built in 1919 while Mr. Layne was employed as pump specialist at the Richmond, Cal. refinery of the Standard Oil Co. of California.

During his connection with the Standard, from 1918 to 1924, Mr. Layne was in charge of all pumping problems, design, construction and operation of refinery equipment at the Richmond plant.

Since his graduation as an electrical engineer from the University of California in 1906, Mr. Layne has held many electrical engineering jobs. He has worked on the sales force of the General Electric Co.; was principal owner and manager of the Sebastopol Light, Power & Water Co., Sebastopol, Calif. from 1909 to 1912; and chief engineer and manager of manufacturing for Valveless Pump Co., Portland, Ore. from 1916 to 1918.

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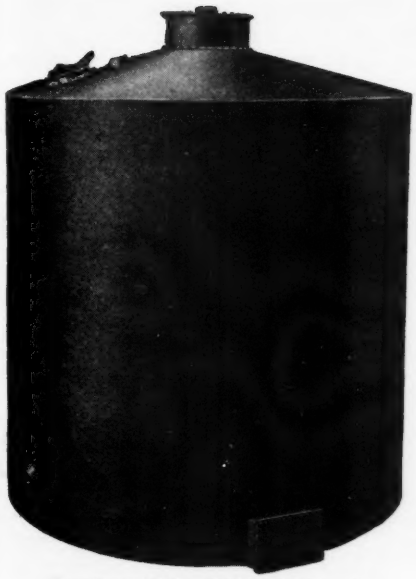

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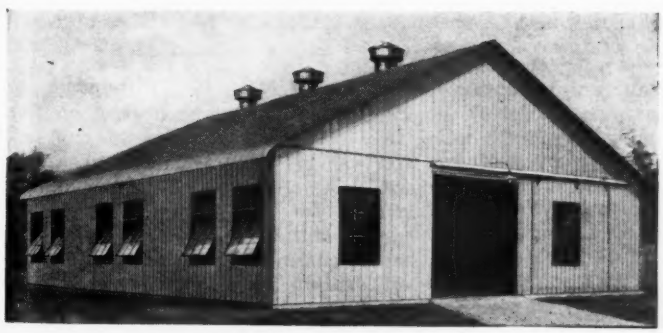

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build one small pump of this type, having a capacity of about 350 G.P.M. against a differential head of about 20 pounds per square inch.

This pump was of the vertical type and direct-connected to a vertical electrical motor. The basic principles of design embodied in this little pioneer centrifugal hot oil pump are those now incorporated in the present day centrifugal hot oil pump. These pumps are in operation on every continent of the world, and have a combined capacity of over one and one-half million barrels per day of hot oil.

THE success of the first trial pump was immediate. A second pump for 1,000 G.P.M. was built and tried. This also was just as successful as the first. Then one was built for 2,000 G.P.M. which was entirely satisfactory. This was followed by many units of 3,750 G.P.M. which were operated for several years, or until the particular process with which they were used was replaced by another. When the new process was installed, the latest type of hot oil centrifugal pumps were purchased for use with it.

All of these pioneer pumps were of the vertical type, with the pump casing at the bottom and the drive on top of rather a tall pedestal. Most of these pumps were steam-turbine driven. The casings were of very heavy cast steel, and the impellers of cast iron. The shafts were equipped with case-hardened steel sleeves where they passed through the bearings and stuffing box.

The impellers were of the enclosed or fully shrouded type. The steady bearings in the pump casing were of cast iron, and of special shape. A large ball thrust bearing submerged in a liberal bath of oil was used. The stuffing box was very deep, and a powerful helical spring was used in the bottom of the box to keep constant tension on the packing. This spring surrounded the shaft. Cold oil from the still-charging pump was fed to the bottom of the stuffing box and to the bearings, so that the leakage from the stuffing box was of cold oil instead of hot oil.

These pumps ran very satisfactorily. During this time as a matter of experiment, one horizontal type of hot oil centrifugal pump was built, by this same oil company. This pump had a capacity of between 5,000 and 6,000 G.P.M. against a head of about 65 pounds per square inch. This pump was quite successful, but some troubles were experienced on account of expansion, and the general experience entirely confirmed the opinion that the vertical type of pump was best for hot oil service.

AT ABOUT this time the manufacture and sale of centrifugal hot oil pumps was taken up on the Pacific coast by one of the largest builders of centrifugal pumps in the world. The same basic principles of design were kept, but the mechanical features were vastly improved.

The pump proper rests on top of the pedestal, or barrel, and the driver is set below, and direct-connected through a flexible coupling. This arrangement permits easy access to the interior of the pump without disturbing the piping or driving mechanism. These pumps may be driven with either electric motors or steam turbines, by far the greater number being driven with turbines.

All parts coming in contact with the hot oil are of steel, many parts being made of chrome-steel alloy to resist corrosion. Spring tension is maintained on the packing, the gland can be operated from the outside by means of a hand-wheel, and the stuffing box is doubly enclosed in a cast iron chamber. A steam smothering connection is made to this chamber and there is also attached a steam jet pump for pumping out any oil vapors that may accumulate in this chamber.

Cold oil is fed through meters to the stuffing box and to the bearings. The bearings are of cast iron, and the shafts are equipped with case-hardened steel sleeves. A special double-casing construction is used that permits the outer casing to be a very simple, strong shape, easy to make sound and tight. The inner casing is under compression, rather than tension stresses, and hence its construction is a simple problem.

These pumps are built and operating with one, two, four and six stages, with capacities of 150 to 500 G.P.M. of hot oil against heads varying from 35 to 300 pounds per square inch. Designs are prepared for quantities as high as 10,000 G.P.M. and for differential heads up to 2,000 pounds per square inch, and temperatures up to 1,000 degrees Fahr.

For hot oil service, the centrifugal pump has many inherent advantages. It is perfectly safe to operate. In all the years of its history, with millions upon millions of barrels of hot oil pumped, not one case of injury to an operator due to pump failure is of record. It is a dependable and simple mechanism.

There is an entire absence of valves, and there are no close clearances between moving and stationary parts to bind, seize or require lubrication. The discharge is perfectly smooth and continuous, there being no pulsation to disturb the balance of operation so necessary in many processes. No destructively high pressure can be built up by the pump, even with closed discharge. No impact at all is produced by its operation. Its space requirements are small and its operation as smooth as that of an electric motor.

Refinery Supply Co. Buys Gravity Balance Rights

TULSA.—The Refinery Supply Co. of Tulsa, has purchased all rights under the H. R. Pierce patent covering a portable specific gravity gas balance. The purchase was made to avoid any possible patent conflict with the R. S. Precision Specific Gravity Gas Balance perfected by the Refinery Supply Co. and now offered to the gas and gasoline industries.

The portable balance consists of a balancing member consisting of a spun bulb filled with air on one end and adjustable weights on the other. It is balanced on a suspension spring. By means of the weights the pressure of air in the float is made to equal the normal day's barometric pressure.

The machine is filled with gas to be tested. If the gas is lighter than air the bulb or float will sink. A manometer is attached to the top of the case and it is merely necessary to subject the gas in the machine to a slight pressure to bring the balancing mechanism back to zero on a scale in the machine. The amount of pressure required to bring the machine back into a balance added to the barometric reading for the day is then divided into the day's barometric reading to obtain the specific gravity.

The gravity balance is a development of many years of experiment on the part of a large number of individuals and companies. Instruments developed in the past have been open to the criticism that they were too delicate to be carried in the field or too slow in their action.

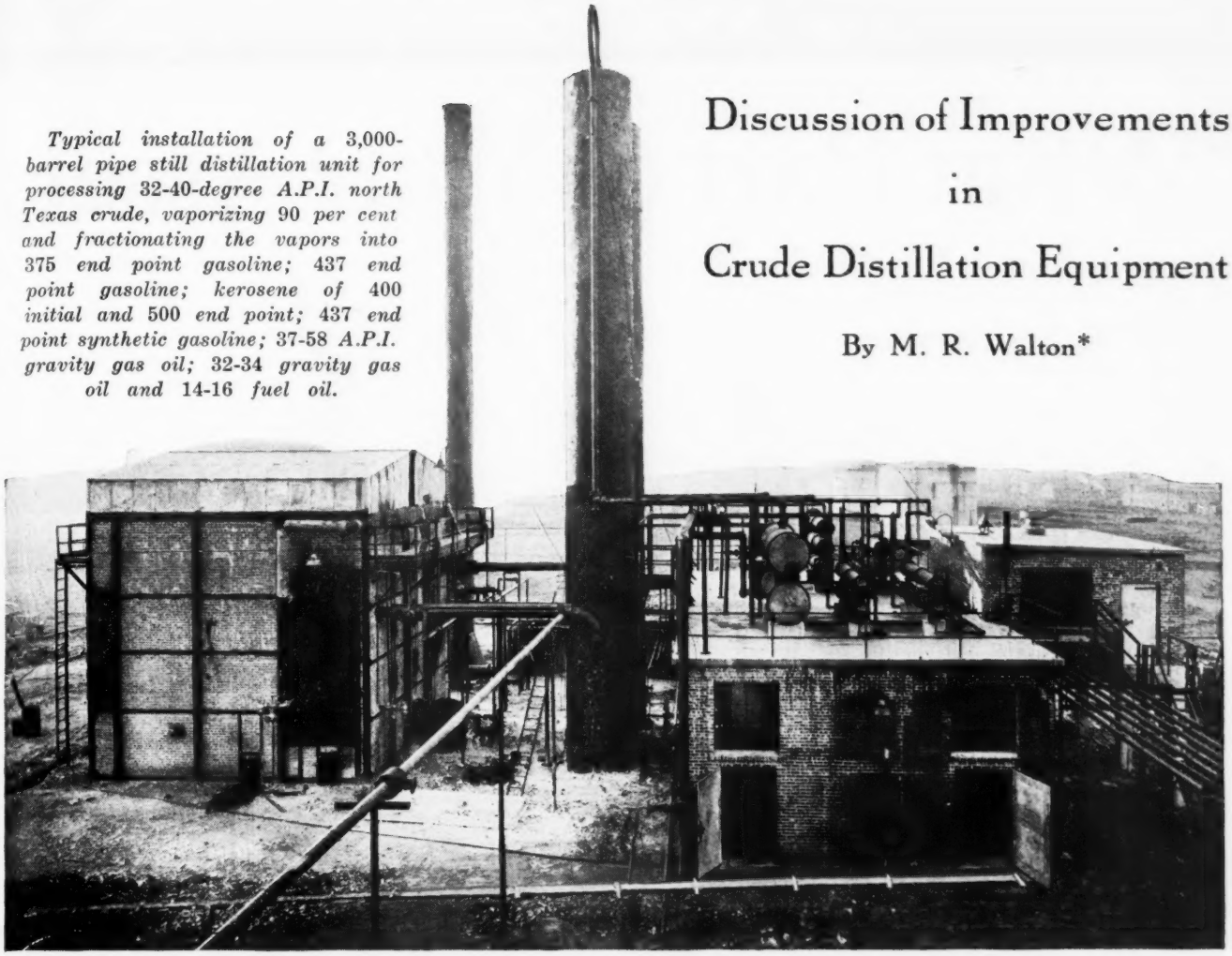
The "Nick of Time" balance is so rugged in its construction that severe jars will not affect it when locked for transportation. Where tests are to be made it can be quickly put into operation by leveling on a firm footing and releasing the locking devices.

Kerotest Mfg. Co., Pittsburgh, Pa., has issued a 48-page booklet on Kerotest valves and fittings of cast steel for various purposes. It makes a line of cast steel fittings especially designed for heavy service in oil fields and refineries. The booklet gives specifications, dimensions and weights of drilling valves for heavy, medium and light duty, Christmas tree valves, line and stripper valves, and many other types.

Refinery and steam valves designed for use with oil and steam at high temperatures and pressures are described and hydraulically operated remote control valves for refinery use where such valves are desirable because of fire hazard. Also automatic valves designed to automatically close off flowing oil wells in the event of fire coming into contact with the well or derrick.

Discussion of Improvements in Crude Distillation Equipment

By M. R. Walton*



Typical installation of a 3,000-barrel pipe still distillation unit for processing 32-40-degree A.P.I. north Texas crude, vaporizing 90 per cent and fractionating the vapors into 375 end point gasoline; 437 end point gasoline; kerosene of 400 initial and 500 end point; 437 end point synthetic gasoline; 37-58 A.P.I. gravity gas oil; 32-34 gravity gas oil and 14-16 fuel oil.

THE over-production that has existed in the oil industry at various times during the past few years, with the attendant low prices and small profits, has made it necessary for the executives in the different branches to study every phase of their particular fields with a view to cutting expenses and reducing costs.

The refiner has had an unusual number of problems to solve as the specifications of his products were changing to meet new and more exacting requirements and equipment was rapidly becoming obsolete for one of two causes—either it would not process the crude into the desired products or the cost of operating was prohibitive.

These conditions have been responsible for many changes in refinery practices and equipment, all to the advantage of refiner's cost and quality of products. The progress which has been made is only a measure of the possibilities in the future.

The cracking unit is a very good illustration of what has been accomplished. This process has without question definitely established itself as a part of the refinery equipment needed to process certain low value stocks obtaining substantial yields of higher grade products.

Up until recently the distillation of crude oil was largely carried on in the conventional shell stills. Improvements in this type of equipment have to a great extent eliminated the batch stills for the continuous method. The results obtained with the continuous cycle were very good and reduced the costs of operation, but a study of the heat efficiency of the shell still either as a single unit or as a continuous battery showed a fuel requirement from 5 per cent in the most efficient, to 10 per cent in some installations and even more in others.

The fractionating equipment on shell stills in many of the older installations was such that most of the cuts made required further rerunning to obtain products of definite specifications. This rerunning was accomplished at the expense of additional fuel requirements.

These excessive costs and inefficient methods led to an intense search for equipment that would operate with a minimum of fuel and produce maximum yields of products of highest quality, the result being the pipe still distillation unit, which at this time offers the refiner the greatest opportunity to accomplish his desire to reduce costs, increase yields and improve the quality of his products.

This unit as has been developed in some of the most successful installations consists of a number of elements properly co-ordinated, these elements being—

Tube Heater Furnace including—
Heater Coils
Flue Gas Recirculation
Air Preheater
Vaporizers
Bubble Towers
Heat Exchangers
Automatic Temperature Control Apparatus
Automatic Liquid Level Control Apparatus
Automatic Liquid Quantity Control Apparatus
Automatic Pump Speed Control Apparatus
Circulating Pumps

The tube heater is constructed to give the greatest efficiency of heat transfer from the gases of combustion to the oil and every attention is given to maintain constant temperatures in the various heating zones. Excellent heat efficiencies are obtained by the installation of radiant tubes in the combustion chamber, these tubes absorbing the radiant heat of combus-

(*Continued on Page* 143)

*Sales manager, oil refinery division Widdell Engineering Co., associated Arthur A. McKee Co.

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(*Continued from Page* 139)

tion, by the counter-flow of the liquid in the convection tubes behind the bridge wall and by the introduction of a preheater in the stack gases for preheating the air for combustion and reducing the stack temperature to a minimum. Preheated air adds materially in obtaining complete combustion of the fuel.

By recirculating a controllable amount of flue gases the temperatures in the furnace are maintained within ranges to give the best results. The maximum temperature in the combustion chamber is around 1800° F. and the temperature of the gases passing into the convection tube section never exceeds a maximum of 1450° F. These low temperatures very materially reduce the maintenance cost of the furnace. Further it is particularly advantageous to have a temperature not to exceed 1450° F. passing into the convection tube section as at higher temperatures carbon deposition in the tubes becomes a problem. With these controlled temperatures and resulting reduction of carbon deposition in the tube heating elements a maximum time on stream is insured.

THE transfer of heat to the crude for processing in the pipe still distillation unit is accomplished in two or three stages. This method of operation increases the flexibility of the unit and permits the addition of the required amount of heat to each portion of the crude to vaporize the fractions that are to be taken off in a particular vaporizer or tower.

The heat in the first stage is transferred heat obtained from various liquids and vapors by means of heat exchangers. The amount of heat recovered in this manner is sufficient to vaporize the lighter fractions of gasoline in the crude, these vapors being carried into towers for fractionation.

The reduced crude from this point is carried through one or two tube heater banks in the furnace depending on the character of the crude and the cuts desired.

If only one tube heater bank is used the crude is heated in two stages—the first heat coming through exchangers, and the additional heat through one continuous coil in the furnace. In passing through the single coil the crude minus some of the lighter products is heated to approximately 750° F., and at this temperature is discharged into a vaporizer incorporated in a tower or a separate vessel depending on the amount of material handled and the quality of the crude. The products vaporizing in this section ascend a tower for fractionation, while the bottoms are drawn off and run to storage as fuel oil or charging stock for cracking units.

The most complete distillation is obtained when the heat is supplied in three stages. Here the lighter gasoline is vaporized by the heat absorbed from the heat exchangers. The reduced crude is then passed through the first pass of heating coils in the furnace—known as the preheater bank—raising the temperature of the oil to approximately 550° F. and at this temperature the oil is discharged into a vaporizer section, the vaporized products passing into fractionating sections with the bottoms accumulating in a reservoir from which they are pumped into the second tube bank—known as the radiant bank. In passing through this tube bank the temperature of the oil is raised to 750° to 825° F. depending on the character of the crude and the products desired. This oil is discharged into a vaporizer sections with the bottoms accumulating vaporized products passing to towers for fractionation, the bottoms accumulating and run to storage as fuel oil.

All products vaporized by the various heating stages are carried into fractionating towers of the bubble tray type. The bubble towers have been worked out on the basis of taking a number of cuts from each tower, one overhead stream and several side streams, the overhead stream coming off in vapor form and the side stream as liquids, also each of these cuts is automatically controlled and each cut is independent of the other. The temperature of the top section is controlled by open reflux or by a vapor reflux condenser. The temperature of the lower sections is controlled by refluxing each section with a proper amount of reflux medium.

ALL of the quantities of reflux and products flowing through the system are controlled by specially designed apparatus, the tell tale being either a thermocouple or liquid level control.

This automatic apparatus controls in close ranges all factors at the predetermined points. However, there is a possibility of quite an adjustable range in each apparatus. This flexibility of control permits taking off fractions from each tower section of various initials and end points, the range of cuts from the crude being very definite as to all intent and purpose the initial of each cut will be the same as the end point of the preceding cut.

As all distillation is accomplished by vaporizing the crude to be processed, therefore, some medium of condensing and cooling these vapors must be available, and in the older shell still batteries referred to in the forepart of this article, the condensing and cooling was accomplished by passing the vapors through coils in condenser boxes filled with water. It was early evident that this was a very wasteful method and that, if properly designed heat exchangers were installed, some of this heat could be recovered. Due to the type of construction employed in the pipe still distillation unit it lends itself readily to the introduction of heat exchangers, where heat is to be exchanged from liquid to liquid or vapor to liquid, and a properly designed pipe still distillation unit must take full advantage of these possibilities.

In the selection of heat exchangers it is very necessary that the designer know the rate of heat exchange; the exact volume of vapors; the specific heat of the various products, and due consideration must be given to the selection of materials and design, as there are corrosive conditions to be met and expansion stresses to be provided against, due to the large heat differential existing in some cases.

HEAT exchangers introduced in the various hot liquid streams and vapor lines in such a manner that the incoming crude can absorb the excess heat makes it possible in most installations to distill off a large share of the lighter gasoline fractions with this recovered heat.

Thus it will be seen that heat is conserved in a pipe still distillation unit, first, in the tube furnace; second, in elimination of rerunning by close fractionation, and, third, by exchanging heat from the hotter to the cooler products.

Positive circulation in the tube heater is very important and as the frictional resistance through the tubes must be overcome with circulating pumps, these must be of such design to insure continuity of service under pressure and high temperture.

Automatic control apparatus for coordinating the elements of a pipe still distillation unit have called for much study and practical experience as the proper functioning of the entire unit is held in tune by these controls.

We have traced by various steps the elements and controls required in the pipe still unit and have seen that, by proper co-ordination of the various elements and devices, the distillation of crude oil can today be carried on in equipment that meets the most exacting conditions and accomplishes this with a minimum amount of space, labor, and fuel, all of which insures a maximum value in the capital investment.

All of the distillation carried on in a pipe still distillation unit can be accomplished with 2 per cent to 2½ per cent of fuel depending upon the amount to be taken overhead and in many cases as much as 90 per cent can be taken overhead at a fuel cost of not more than 2 per cent. Such a unit will produce several different cuts of gasoline, naphthas, kerosene, and gas oil, pressable wax distillate and fuel oil.

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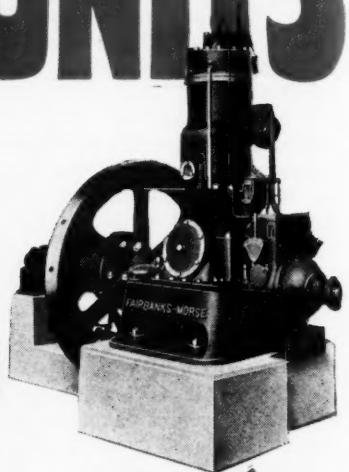

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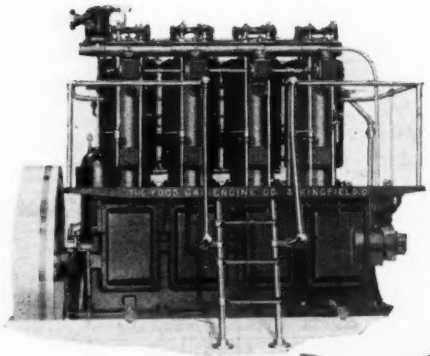

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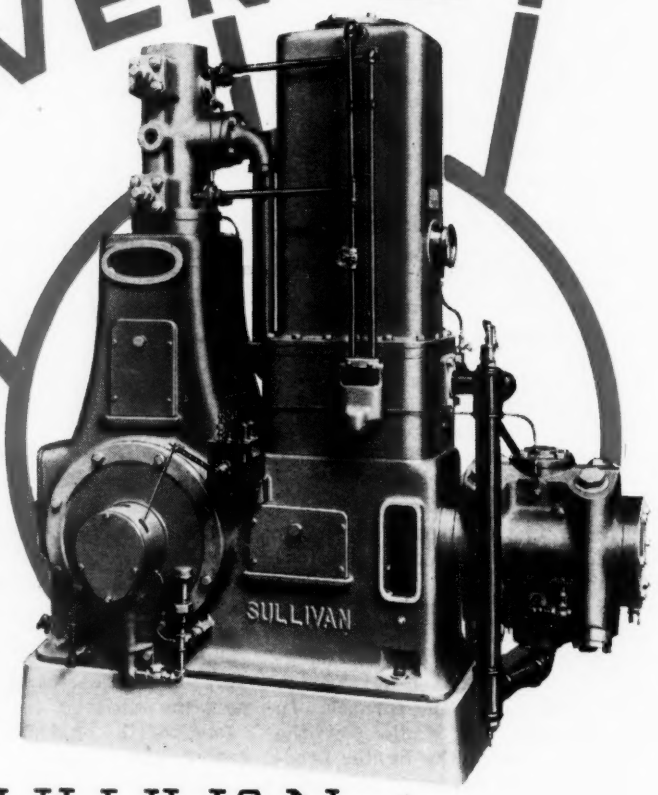

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Filtering Oil By Percolating Method; Restoring Spent Earth

By G. G. Brockway

THE refining of petroleum is probably the least standardized of any of the older industries in this country. That is why it is so interesting. Also that is why the changes in practice are so rapid that the refiner of today must be very alert to keep abreast of the many new devices and processes that are being introduced.

Competition has been the spur which has incited refiners to almost heroic efforts to cut cost by the discarding of old methods and the introduction of new inventions and appliances. In plants where old methods are still in use at a profit, the loss is there nevertheless because the higher costs are there.

That part of the plant which has to do with the decolorizing of oil has received its share of attention in recent years and it is proposed in this article to point out some of the more important means by which refiners have cut costs in their filtering plants and at the same time have improved the appearance of the product and made marked progress toward uniformity of output.

Although the filter house is designed for the purpose of decolorizing oil, the work to be done by the filters can be greatly facilitated by the proper handling of the oil before it gets there.

The design and operation of still has much to do with the cost of filtering. Improperly designed steam spiders in the stills or the undetected plugging of the holes in the spiders will result in the scorching of the oil. The color of the oil is thereby darkened, and worse, it is set so that it is only with great difficulty that the filters can remove it.

Oil will darken or scorch at less than 150° Fahr. Furthermore, oil which is not cooled sufficiently before it is allowed to come in contact with the air will darken in color and the difficulty of filtering it will be considerably increased.

Testing for Color and Filtration

WITH neutrals and steam refined it is essential to verify color and filter test for every still run as a check on stillmen and their equipment. The color of very dark steam refined may be read by diluting 2½ per cent of the steam refined with 97½ per cent of water white kerosene. A laboratory filter of good design if properly operated will give accurate indication of the filterability of cylinder oil and neutral.

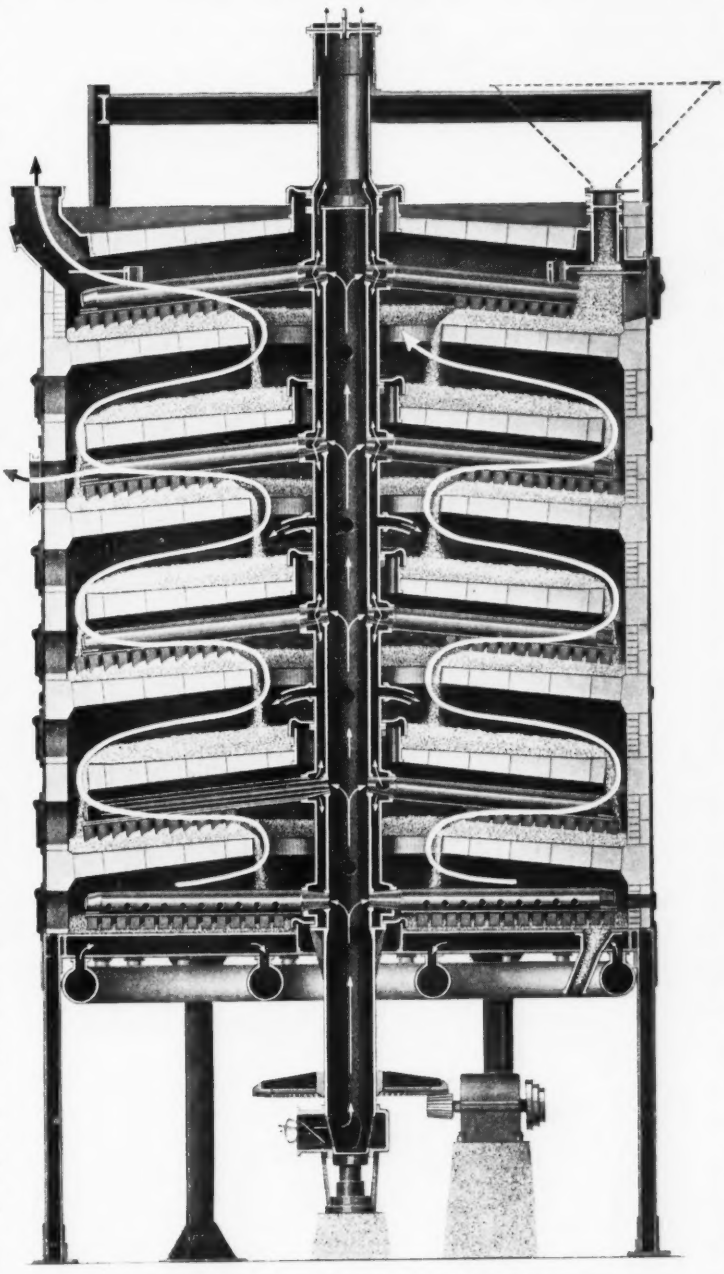
At our own demonstration plant we are able to do this regularly. Such a filter will also compare different brands and mesh of new earth. In addition it will assist in establishing the value of used earth after each re-burn so that earth may be thrown away or retained according to its value.

Improper still equipment, improper handling of oil in the stills, and after this has left the stills, are causes of high costs which need not be tolerated. Also, open top filters and platform elevators are insidious wasters of labor. Extra handling of earth to and from wash filters falls in the same category.

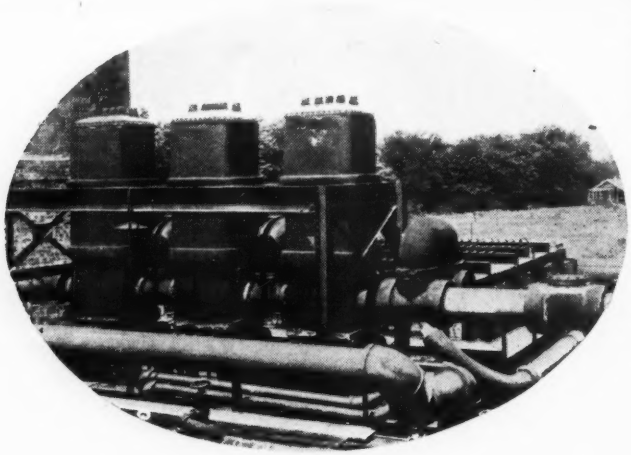
Filtering by gravity through improper mesh earth for the oil being handled, accounts for low production per ton. Furthermore, oil should be filtered at its proper temperature and no hotter. If the oil has been passing to the filters at too high a temperature, additional cooling capacity on the hot oil line will pay for itself in a surprisingly short time.

To maintain the correct filtering temperature on neutrals, cylinder stocks, cut stocks, wax or petrolatum, automatic heat exchangers may be installed at low cost. Where such devices as coolers and heat exchangers are needed it will be found that their installation will be paid for in just a few weeks through the savings effected by the greatly increased yield of oil per ton of earth charged to the filters.

In charging filters the earth should be leveled off and tamped at least three times during



Sectional view of multiple hearth clay-roasting furnace



Left—Leach Fracto Condensers used in the pipe still installation recently added to the Aetna Oil Service refinery at Louisville, Ky. A. T. Judy, superintendent of this refinery, describes the high efficiency of the installation in the accompanying article.

"We think very highly of this unit"

(from National Petroleum News)

A. T. JUDY, superintendent of the refinery of Aetna Oil Service Inc., Louisville, Ky., writes that a 2000-barrel Foster pipe still with towers, heat exchangers and automatic control, has been added to the refinery's equipment. Mr. Judy describes the new installation as follows:

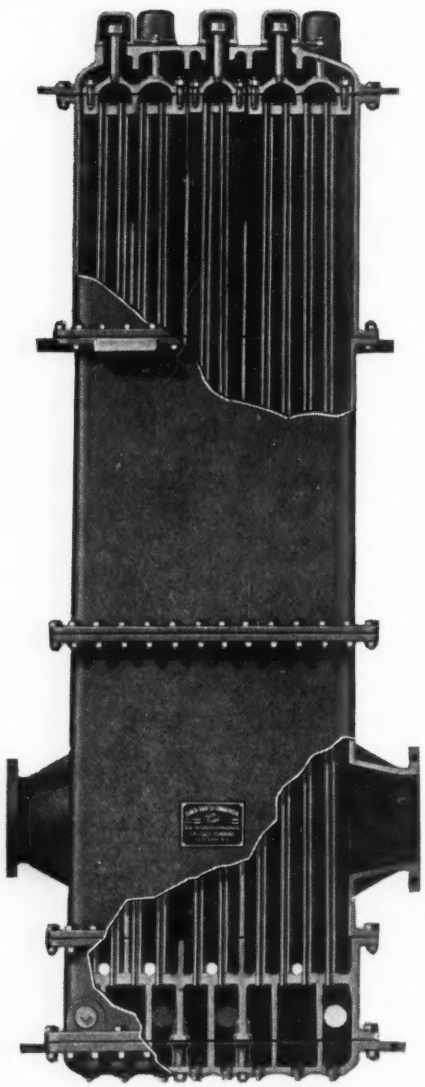
"Plans and specifications were furnished by H. S. Bell, consulting engineer New York City and the equipment was erected by our company.

"The unit is so controlled that all finished products are manufactured without re-running of any of the overhead products. Considerable saving was effected in construction as four 400-barrel stills were torn down to make room for this unit and with some alterations the foundations were made use of.

"With automatic heat and liquid level controls, it is possible to operate this unit with only one man on a shift.

"The unit is now operating at 1500 barrels daily, taking 76 per cent overhead. This really represents an overload as the unit was designed for only 55 per cent overhead. The feature of this unit is the low fuel consumption. Less than one gallon of oil is used per barrel throughout. Several test runs have been made and an overall efficiency 72 per cent has been obtained. We think very highly of this unit."

Below—Sectional photograph of Leach Fracto Condenser in above installation.



LEACH

Fracto Condensers

Heat Exchangers and Dephlegmators

C. H. LEACH COMPANY

225 Broadway — New York

Branches at Boston, Mass. and Elizabeth, N. J.

Leach Heat Exchange Apparatus is patented in United States and foreign countries.

charging, to prevent channeling. As the big lumps of coal will roll to the edge of the pile leaving the fine in the center so will the larger grains of earth roll to the sides of the filters if the earth is allowed to pyramid much during filter charging.

Leveling off and tamping keeps the whole charge of earth homogeneous and prevents having the larger grains roll to the sides of the filter thus leaving a core of fine earth down through the center of the filter. In a filter which has been incorrectly charged the coarse earth next the sides of the filter will soak up quickly, but the fine earth in the center will not.

As a consequence, when the filter goes on production the oil will travel toward the sides of the filter and percolate through the coarse earth and little or none will filter through the closely packed fine earth in the center.

It is obvious that a filter so charged can not give the yield per ton that it should, as there may be several tons of earth in the filter which are only taking up space and not performing any filtering function at all. In addition to this, such a filter is very difficult to drain, wash and steam. Further difficulty is encountered in the re-burn of the earth.

Earth handling equipment which causes dusting has been found at a number of plants to be the source of the trouble just mentioned. Filters charged with batches containing a goodly percentage of pulverized earth may even become entirely sealed against oil flow by having a stratum of this dusted earth form right across the filter thus effectually confining the oil above it.

Filtering Temperatures

THE earth in the filters and the oil being filtered should both be at the correct temperature. Filtering temperatures should be approximately as follows: For cylinder stock, straight, not over 150° Fahr.; for cut stock (stock diluted with naphtha), not over 125° Fahr.; for neutrals, not over 100° Fahr.; for wax and petrolatum, about 25° Fahr. over their melting points.

Closed System

ONE straining with neutral when the usual colors are desired is sufficient. The same for wax and petrolatum. The oil with the most carbon, namely cylinder stock, both straight and cut, is the hardest to filter and requires the most straining. A filter which has been run so long that it has very little decolorizing value may be used to strain the raw stock.

The effluent from this filter may be directed to two or more filters off color. It is from these filters that the filtrate is secured to soak up newly charged filters and to supply filters running on color.

By means of a closed system this all may be done with the original pumping, starting at 35-45 pounds pressure, going through the filters and heaters in the required order. Through the agency of the one pumping in a closed system, contact of the oil with the air is avoided and oil thus handled filters with the greatest facility.

G. G. BROCKWAY

Mr. Brockway's connection with the oil industry has been lifelong.

He was early identified with the Seneca Oil Works at Warren, Pa., where he first became interested in the filter plant and its problems. In 1912 *he designed the Brockway earth dryer which he has since manufactured and marketed. This dryer has become standard in this country and is represented in many foreign countries.*

During the war he served as lubrication engineer in the air service at Park Field, Memphis, Tenn.

Some years ago he organized the Warr Penn Refining Co. and designed and built its plant. He operated and managed this refinery for seven years.

In the latter part of 1926 *he severed his connection with the Warr Penn to devote his entire attention to the marketing of the Nichols Herreshoff Earth Roasting Furnace manufactured by the Nichols Copper Co., of New York in conjunction with the Pacific Foundry Co., of San Francisco. He has designed and built a complete demonstration plant at Warren, Pa., and has rounded out his organization for selling engineering and servicing this furnace.*

Draining, Washing, Steaming

AFTER a filter has finished "on color" and "off color", and has taken its turn at straining raw oil, it is drained. This may be accelerated with air pressure or steam. The latter is of further assistance as it also cuts out the slime which is deleterious to efficient filtering.

The filter is then washed with a good grade of naphtha. Fifty-six gravity or higher is desirable for a good wash. This is not an extravagance, as the quantity of high gravity naphtha required is much less than the low gravity and with good steam still and condenser equipment there is little lost.

Besides, with a low gravity wash, less oil and naphtha are recovered from the earth and the residue in the earth is burned at the time of regenerating the earth. This not only results in the loss of the oil and naphtha retained by the earth, but its burning does not add to the efficiency of the earth treating process. Washes should be heated to 150° Fahr. and should be repeated until the wash is clean.

Then the filter is steamed. There should be a steam pressure reducer, steam gauge, and a water separator on the steam line near the filter. Use a pressure of 45 pounds if the filter will stand it. Choke in the outlet to see that the steam reaches all the earth and continue steaming until no oil shows on the condensate. Release the pressure at the top and remove the filter head to cool and dry.

Grades of Earth for Filtering Different Oils to Secure the Highest Efficiency

FORMERLY 16/30 earth was used for nearly all filtering. However, it has become evident that the greater the earth surface area exposed to oil in the filter, the greater the production. Therefore, wherever the nature of the oil will permit, the finer earth is now used.

It has been found that 30/60 earth will have an efficiency of approximately 20 per cent over 16/30 and 60/90 will have an efficiency from 10 to 15 per cent greater than that of 30/60. As a general thing neutrals should be filtered through 60/90 and also steam refined in solution. Steam refined, bright stock, petrolatum and wax should be filtered through 30/60.

It naturally requires longer time to soak a filter of finer earth; and the draining, washing and steaming take longer, but where sufficient number

of filters are available so that the filters can be run slower, the production through its use will be greater by the amount indicated above.

This is especially true in the cases where light colors are desired, which really amount to every case, as longer runs of light colors mean greater production of any desired color. Earth that has been burned or roasted should not be allowed to stand where it can absorb moisture from the atmosphere as it will materially decrease the production. This is one objection to the air system of earth conveying.

Filter Records

AS THE cost of the earth is the largest item in the cost of filtering it is something that should be watched very carefully. The filter piping and the filter run-down tanks should be so designed and of sufficient number that a separate record can be kept for each filter. It is not meant that there should be a run-down tank for each filter, but somewhere between each filter and the common tank or manifold leading into the tank, devices should be installed in the piping to determine and control the speed at which the filter is running in gallons per minute or the number of hours it has run when the rate of flow is known.

The oil pressure on the filter should be constant and the rate of flow should be constant. This rate of flow can be made constant by running the oil stream through the size of hole in the line that will secure it. By the means indicated, the control of the speed at which filters run is put in the hand of the superintendent, where it should be, and the unhappy situation of having different operators, with their different personal equations, exercising their varying judgments about the rate of flow, is done away with once and for all.

The superintendent must watch the runs very carefully for an extended period, keeping in mind the quantity it is necessary to run through in a day and the number of filters with which he has to do it. Then when this is determined, he should design filter record sheets with spaces for the information his particular plant requires, such as the following:

The amount of earth in the filter.

The length of time it was soaked.

The hours or gallons in production of oil to color and the same for oil to be filtered further.

The number of hours for draining the filter, washing and steaming.

The number of hours idle during the entire operation.

Any other information he may require to have a complete record of the value of the filter to his plant.

To Prevent Channeling

MANY experiments have been made to design a filter to prevent channeling of oil. Filters of smaller diameter at the bottom than at the top and others of smaller diameter at the top than at the bottom have been used.

Circular angles or deflectors around the inside of the filter at various heights have also been used, but with varying success.

In addition to our earlier suggestion for the proper packing of the filter, the following will prevent excessive channeling—Insulate the outside of the filter or at least place it in a tight compartment where the temperature of the earth and the oil in the filter will remain practically the same throughout its run.

Then be sure the earth is at the correct temperature as it is charged to the filter and that the oil is at the proper temperature at all times. This will eliminate the necessity for constant use of coils around the filter.

Such steam coils heat only the filter shell and the earth very close to it and the oil in that section of the filter will be so thin from heat that there will be less resistance as it flows rapidly through that portion of the earth, which is one way that channeling occurs.

It goes without saying that steam coils should never be used inside a filter, as they are likely to scorch the oil. Moreover, any leaks in these coils will produce moisture which is very detrimental.

Loss of Naphtha in the Filtering of Cut Stock

THIS occurs at three different points. First in the blending of the steam refined and the naphtha. When mixing to a specified gravity, regardless of the percentage of each oil, blending can take place at the pump. With the suction open on the steam refined tank and on the naphtha tank, to the proper degree, the proper gravity on the discharge side of the pump will be secured. When this mixture has been pumped to its destination it will be thoroughly mixed.

Whenever the blended oil and naphtha or gasoline must be carefully measured, the stock should be pumped into a vapor tight tank first and the naphtha pumped to the bottom at at least four points. Perfect blending can be secured in this way and the vapors may be gathered through a gathering system.

The second point at which there are excessive losses is on the filter run-offs. This loss may be reduced by proper design of line and tanks and with multi-tubular coolers of home-made design on the finishing lines.

The third loss is on reducing at the stills.

These losses in extreme cases run as high as 2 per cent loss in blending, 3 per cent in filtering, 2 per cent in heating to a temperature sufficiently high for centrifuging 3 per cent in reducing and 3 per cent in washing the filters. These losses will be considerably lower where conditions are thoroughly understood and sincere efforts made to reduce them.

Earth Conveying Systems

THE cost of handling earth with platform elevators is too high from the labor standpoint. Earth cars are more or less satisfactory on the ground level to dump the earth into bucket elevators. Bucket elevators for conveying the earth vertically and belt for conveying earth horizontally are very satisfactory. The bucket carrier type for handling earth both vertically and horizontally is also highly efficient. The method of handling earth by air at excessive velocities has been extensively tried out, but in most cases abandoned, as the excesive velocities cause abrasion or breakdown into consequent powdering which causes trouble as indicated heretofore.

The Storage of Earth

EARTH ready to burn can be satisfactorily stored in quantities. However, burned earth, generally speaking, should not be stored, as it accumulates moisture by absorption from the air and by condensation.

The Roasting Earth

THERE have been many types of burners or retorts used for the purpose of drying out the moisture and burning the oil remaining in the earth, and until recently they have been considered sufficient for the purpose.

The oldest burner for this purpose was the old hand-raked beehive oven. This was very inefficient as the earth was not washed in the filters to any extent for the oil in the earth was needed to fire the earth. Then various forms of horizontal, rotary and vertical burners were used to make it possible to wash and steam earth better. In comparatively recent years attention has been directed to the idea of utilizing the same type of furnace as has been used so successfully for 40 years in the metallurgical industry—the multiple hearth roasting furnace.

The principle of treating ores and treating fullers earth being practically the same, it has only been necessary to make a few changes in the ore roasting furnaces to adapt them admirably for the particular service of

revivifying fullers earth. The introduction of this type of furnace into the petroleum industry marked one of the most important improvements ever made in filtering practice.

THE purpose of this furnace is to dry out the moisture, burn off the oil, and removed the accumulated carbon from the grains of earth. The old retorts not having the time element and the presence of a controlled amount of oxygen could not affect this carbon, but rather baked it on, whereas with the multiple hearth furnace there is the right amount of exposure of all of the earth to the heat, over a controllable time period and the oxygen in the introduced air uniting with the carbon on the earth results in the combustion of the carbon.

The temperatures in the multiple hearth furnace are lower than in the old type burners, thus preventing the small amount of vitrifying of the grains which was formerly experienced. It is possible now by the use of this type of furnace to retain earth in service indefinitely by the addition of only sufficient new earth for the necessary make-up. This filtering efficiency may be maintained at a point much higher than the average efficiency of the earth handled in retorts. In many cases discard earth can be reclaimed very satisfactorily for a prolonged period of use, but this depends largely on the condition of the discard earth including the extent to which it has been vitrified in the old retorts.

How such a furnace is constructed and how it operates can readily be seen in the accompanying illustration of the Nichols Herreshoff furnace which may be taken as representative of the type. The furnace consists of two main parts—a central shaft to which rabble arms are attached, and a number of circular hearths, usually eight, built one above the other around the shaft. In operation the central shaft rotates and carries the rabble arms around with it.

The fullers earth is fed from a hopper into the top of the furnace and is dropped in regulated amounts on the top hearth. Here the rabble teeth, which are held at the proper angle in the rabble arms, turn the earth over and gradually plow it across the face of the hearth from the outside toward the center until it is discharged through the proper opening on to the hearth below.

Here the teeth in the rabble arms are placed at an opposite angle to those above so as to turn and plow the earth from the inside toward the outside of the furnace where it again drops to the hearth below as shown in the illustration. This operation is repeated until the earth finally discharges through the outlet placed at the outer edge of the bottom hearth.

The speed at which the earth travels through the furnace, and the consequent time to which it is exposed to the temperatures and the oxidizing action of pre-heated air on the various hearth is regulated by the speed at which the central shaft is rotated and angle at which teeth are set.

Heat from the burners passes upward, through the various ports and to each hearth, as shown in the illustration, and gradually raises the temperature of the earth as it descends from hearth to hearth, so that it has the proper pre-heating before it is subjected to the oxidizing action on the firing hearths. Temperatures on the various hearths are accurately regulated according to pyrometer readings.

The bottom hearth of the furnace is air cooled and the bottom rabble arms are so constructed that they spray a continuous stream of cold air over the thin layer of earth that is being rabbled across the cooling hearth. The earth discharged from the outlet is cool enough for immediate handling.

Welding Saves Delay In Crude Shipment

NEW YORK.—How a delay in transportation of heavy crude from the field to the gathering lines in a new field recently by oxy-acetylene welding process was avoided, is told in the September issue of "Oxy-Acetylene Tips" published by the Linde Air Products Co. at 30 E. 42nd St., here.

In this particular instance, three large steam coils were fabricated from the pipe with welded joints throughout. Pipe stands were erected to hold the coils, and after headers and joints had been welded, steam mains were installed so that the condensed steam would run down into one corner. The welded heater was completed in short time and the crude oil was fluid enough to run to the refinery.

The same issue tells how to weld gray castiron, which, because of its valuable properties has many uses wherever metal parts are used. Because of its brittleness, however, the welder must understand the properties of gray iron, particularly as affected by heat, the company states. There will then be no difficulty in making sound, easily machined welds. Properties and methods of welding gray iron are explained.

ST. LOUIS, Mo.—A bright-colored four page leaflet calling attention to its fire brick, has just been published by the Laclede-Christy Clay Products Co. A partial list of the principal industries the company serves includes that of the oil refining business. Sinclair Refining Co. and The Texas Co. are among those mentioned as users.

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Combustion and Distribution of Heat In Refining Processes

By Herbert A. Ross

THE efficient production of heat by the process of combustion and the economical application and distribution of the product is a matter of considerable importance in the cost of petroleum refining processes.

Heat is the product of an involved natural law called the combustion of carbon. This combustion is an intense chemical reaction, wherein the elements of carbon and oxygen combine to form the compound called carbon dioxide. The resulting heat of this combination is produced in a very rapid manner. Fortunately, we can, within definite limits and according to fixed laws, conserve this heat and usefully apply it. At the same time, extreme care must be used to insulate the element from the diluting effect of the atmosphere, else it may be as rapidly dissipated as it is evolved or produced, and loss result.

It is a common practice to speak of the carbon used in the production of heat, as fuel. Thus in a general way, we say that we consume so many pounds of coal, gallons of fuel oil, or cubic feet of gas, to produce heat. We use these particular forms of carbon for the reason that they are the cheapest and most available source of heat energy that can be obtained at the present time.

The conversion of carbon into heat energy requires that some form of manufacturing process must take place.

How many refiners consider themselves in the dual role of manufacturers of heat and of petroleum products? On the other hand, isn't it more often the case that fuel is considered a necessary evil and only a means to the desired end?

The refiner as a matter of good business policy and in order to maintain his place in the marketing picture, must always be particular about the quality of his product. He is doing business in a strictly competitive market and must produce a marketable product in conformity with very rigid specifications.

How many manufacture heat energy by the process of combustion as carefully as they do their oil products? After the heat is produced, how carefully do they distribute it and apply it to the manufacturing processes?

The cost of fuel is a heavy expense item and it is frequently the case that considerable saving or profit may be obtained in the necessary manufacture of the heat in question, while the main business of refining is being conducted.

HERBERT A. ROSS

Mr. Ross for the past two years has been associated with H. S. Bell, petroleum engineer, New York City, and with the National Petroleum Association as steam and combustion engineer. During that time he has surveyed some 25 refineries. This work has included design of new boiler plants, steam systems and heat exchange equipment. Old boiler plants, steam systems, stills and furnaces have also been remodeled so as to afford better efficiencies.

Previous to his association with Mr. Bell, Mr. Ross was for 8½ years master mechanic at the Paulsboro, N. J., refinery of the Vacuum Oil Co., being in charge of the power and combustion departments of the plant.

As an argument, suppose the refiner, instead of manufacturing his own heat, could purchase it in the form of steam and hot gases, from a company that manufactured such a commodity. Naturally this company would have to dispose of the product in question at a profit, and would therefore be compelled to charge the consumer on a basis of the producing cost, plus a legitimate profit. Under the circumstances the consumer would be solicitous about the economical disposition of that which he purchases. As a matter of fact, the oil refining industry purchases electrical power in heavy amount. Is it wasted? Not if it can be prevented.

If the foregoing is an illustration, the question arises,—why, figuratively speaking, doesn't the refiner produce heat at a profit, and sell it to himself, likewise at a profit? Surely, he cannot find anywhere a customer so easily satisfied! Here at least, is a profitable outlet for a product he manufactures that has no competition in an open market. On the other hand, may it not be a fact that the reason he manufactures his heat and applies it so unprofitably, is occasioned by the complacency and self-satisfied attitude of his best customer (HIMSELF) and this customer's willingness to pay himself from his own pocket, forgetting in the meanwhile that his strongest competitor is reaping the harvest of economic heat production in the conduct of his enterprise.

Thus, if one refinery consumes 50 pounds of a certain fuel to process its barrel of crude oil, and another, 100 pounds of the same material for the same purpose, and both of them are producing similar products, it is obvious that the last named sustains a heavy handicap in his manufacturing costs.

THE plant operating under the latter conditions cannot hope to overcome its transgressions against economic manufacturing procedure in this particular entirely, by increasing its unit of production. Such methods have frequently been tried in an effort to show a manufacturing profit and have failed.

Several important distinctions, however, must be considered in this connection. Each refinery has its own peculiar constant heat demand which must be satisfied, regardless of the quantity of crude it handles per day. This demand occurs from the necessity to heat buildings, tanks, and so on and provide insurance against fire hazard. Radiation losses from the steam supply system exact a constant toll also. Thus, if a plant has a capacity of 5000 barrels per day and only utilizes a fraction of it, the consumption of fuel per unit of production is usually increased. On the other

hand, enforced production beyond an economical heat producing capacity will usually afford similar results.

Another fact that must be considered, is the grade of the crude that is processed, and the number of products that are derived therefrom, together with their characteristics.

Again! Consideration must be afforded the percentage of primary distillation products which require additional heat for re-running or other processing. These facts, however, must not be construed as affording any excuse whatever for the refinery to ignore the fundamental principles of economic heat energy production or application, and rely entirely upon the aforesaid increased production effort in order to obtain a profit.

Attempt to compare fuel consumption between refineries on a basis of production or crude run, then, is of little value, excepting where all of the conditions are known to be similar in character.

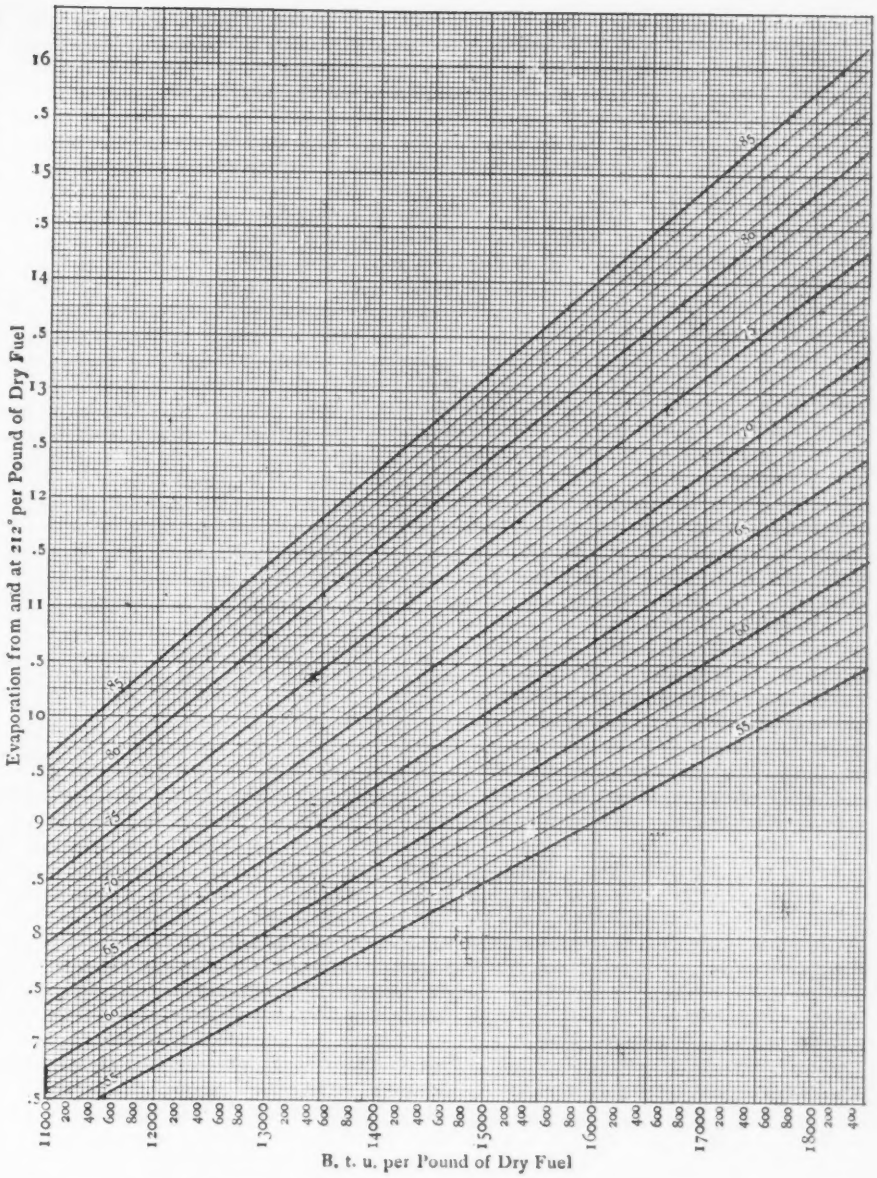
EACH refinery's heat situation is a distinct problem requiring individual treatment and if a fuel comparison with other refineries is desired, some common basis of calculation, applicable to all alike, will be necessary. This information may be obtained by the use of authentic and established formulae relative to the production of heat. Likewise, the volumes of heat necessary to fractionate or process definite quantities of given crudes are fairly well established. Therefore, briefly stated, the answer desired may be correctly obtained by calculating the heat units produced and consumed. The difference, minus unavoidable losses, will, within reasonable limits, denote the percentage of avoidable fuel loss.

* * *

With the foregoing facts established, it will now be in order to analyze this question of combustion in a more specific manner. To indicate some of the causes for loss and how they may be avoided, and then to present a method of economic procedure that has been tried, and proven to be remarkably successful by the results obtained.

THE previously mentioned fixed or volatile carbon called fuel used in the production of heat is not obtained in an entirely pure state. Each pound of coal or fuel oil will contain certain incombustible matter which affords no appreciable amount of heat. Coal will usually be found to contain much heavier percentages of this material than fuel oil.

It is the common practice to purchase these heat producing materials on a basis of weights instead of units of heat, with the result that considerable loss may occur. Probably the coal will be purchased on the basis of analysis, but it will invariably be found that there is a wide difference between an analysis secured from a sample of the fuel delivered, and that obtained at the mine. A concrete illustration of this fact was recently noted and is related here as an example.



Efficiency chart. Calculated from Marks and Davis' tables. Diagonal lines represent per cent efficiency

A refinery was purchasing 2000 tons of coal per month on a basis of the following analysis:

Moisture	2 to 3 per cent
Volatile carbon	30 to 35 per cent
Fixed carbon	60 to 55 per cent
Sulphur	1.5 to 2 per cent
Ash	6 to 8 per cent

Calorific value—14,000 B.t.u. per pound.

Considerable trouble was encountered in burning the coal purchased, and despite the heavy expenditure of money which had been incurred to purchase new equipment and modify old conditions, severe fuel loss still continued. Finally samples of the coal delivered to the plant were sent to a prominent laboratory for analysis, and in due time the following report was received:

Moisture	3.0 per cent
Volatile carbon	25.0 per cent
Fixed carbon	45.0 per cent
Sulphur	6.0 per cent
Ash	20.0 per cent

Calorific value—11,500 B.t.u. per pound.

HERE is an instance where the refinery was not receiving by approximately 18 per cent the value of the fuel they were purchasing. Resolving this to an actual loss basis, instead of consuming 2000 tons of coal per month, 360 less tons should have been purchased. Additional to this loss there must also be considered the fact that, due to poor quality of coal, proper furnace ef-

ficiencies were unattainable and additional loss occurred in this particular.

Fuel oil will generally be found to contain less foreign matter than coal, but instances have been found where moisture, sulphur, asphaltic and other foreign materials have reduced the calorific content as much as 8 per cent.

From the foregoing it is very evident that much attention must be given the importance of the material from which the heat is produced, for the reason that possibly savings of from 5 to 20 per cent may be obtained at the source, with but little effort.

Next in order, will be a determination that the heat is efficiently produced from the fuel. Here again loss in heat production, by incorrect combustion of the fuel, may at times amount to 50 per cent. The factor controlling this loss, within certain limitations, is the human element, the fireman. Obviously, he cannot produce heat economically with improper or unsuitable equipment. In many cases however, it will be found that equipment has to carry the burden of blame for human inefficiency, whereas a little more intelligence and effort applied to the job in hand will produce astonishing economic results.

Next in importance is the mechanical condition of the equipment and its ability to absorb the heat. It must be understood that when we speak of heat efficiency, what is really meant is the manner in which the heat is first produced in the unit and then absorbed, or technically speaking, the combined efficiency of heat absorbed to the heat produced. Herein will be found some important facts that require explanation.

A boiler or still is usually considered as a complete unit. This, however, is not altogether a true fact. A furnace may consume the fuel introduced to it in a very efficient manner, but the heat absorbing unit (the still or boiler) may not be able to abstract more than 50 per cent of the heat the furnace produces. It is necessary for the purpose of calculation to consider the heat producing and absorbing equipment as a combined unit and so term it, but in order to avoid fuel loss, we must first have the efficient furnace and grate efficiently operated, and then the efficient still or boiler to absorb that which the furnace produces.

THE application of heat to the processing of petroleum has three distinct phases, as follows: First, heat applied directly from the furnace to the oil in the still. Second, indirect heat in the form of steam applied to the oil in the still. Third, heat from the still applied to the steam introduced to the oil, in order to satisfy the existing temperature difference between the steam and the oil. Fuel loss may occur at any one or all of these three places.

Consider the boiler and assume that we are burning coal having a calorific value of 13,500 B.t.u. per pound dry basis or a fuel oil having an ultimate heat content of 18,500 B.t.u. per pound. In order to produce a given weight of steam at a temperature of 212° Fahr. from water at the same temperature, or as the engineer terms it—evaporation F. & A. 212° Fahr.—it will be necessary to consume a certain weight of fuel. This fuel having the values noted, consumed in the furnace and the percentage of the heat absorbed by the boiler to produce the steam will determine the combined efficiencies which have been obtained from the fuel consumed.

In other words, if we consume 13,500 B.t.u. and only 6750 B.t.u. are absorbed, we obtain an efficiency of only 50 per cent. The accompanying efficiency chart published by Babcock and Wilcox, in their 36th edition of "Steam", illustrates this in graphic manner and will be found valuable for the determination of other efficiencies in connection with heat produced and absorbed under boilers.

WE MAY not understand that fuel loss can occur directly at the steam producing equipment. After the heat represented by the steam has been produced, whether efficiently or otherwise, a further fuel loss may be occasioned by the volumes of steam permitted to exhaust directly to the atmosphere or to waste away in sewers. Countless small steam leaks exact their toll. Uncovered or poorly insulated steam lines and worn reciprocating steam surfaces complete the picture. The increment of loss in the steam producing equipment alone is frequently found to be out of all proportion to the cost of the necessary effort or repairs to abate the various uneconomic conditions.

The heat produced at the stills and absorbed by the oil is the next point where heavy fuel loss may occur. As in the case of the boiler, we have the combined unit of furnace and still, and again the factor of a combined efficiency. There is, however, a wide difference in the two fluids, the water and oil which absorb the heat produced in the furnaces. With respect to the boiler, the water contained therein will vaporize under sea level atmospheric pressure conditions at one temperature only, namely, 212° Fahr. As long as any water remains in the vessel, its vaporizing characteristics remain unchanged under the conditions given. The total heat contained in a pound of steam under these same conditions is 1150.4 B. t. u. In other words, approximately one B.t.u. of heat has been required for each degree Fahr., that the temperature of the steam has been raised above the temperature of melting ice, which is approximately 32° Fahr. One other matter in this connection that has an important bearing on fuel economy must be remembered. This is the fact that we can produce and maintain heat at much higher temperatures in the boiler furnace than we can in the still furnace without doing any damage.

THE crude oil in the still has entirely different heat absorbing characteristics from the water. Under the same atmospheric conditions the fluid has a number of different boiling points for the reason that it is a compound of complex hydro-carbons, each one of which has its own particular boiling point and temperature peculiarities.

Thus part of the fluid will boil or vaporize at a temperature of 80° Fahr. or less and will require less than 125 B.t.u. per pound for the purpose. Heavier fractions may not vaporize under a temperature of 600° Fahr. and yet they will not require over 350 B.t.u. for the purpose. Again, while it was necessary to furnish one B.t.u. to raise the temperature of one pound of water one degree Fahr., this same heat unit will raise the temperature of one pound of oil approximately two degrees Fahr. or more, dependent upon the gravity of the material. Furthermore, care in the application of heat to the fractionation of lubricants is necessary in order to prevent a cracking effect from occurring. High furnace temperatures necessary for the efficient combustion of fuel, then, cannot be maintained in the average still furnace of today, so that probable loss in this connection must be reckoned with.

Due to the varying characteristics of the crude oils originating in different fields and again the varying products the refinery may derive from that crude which it handles, it is not expedient to present a general combined fuel efficiency curve covering the whole situation, as was done with the boilers. However, in a given refinery and for any given crude or products of the same combined still and furnace efficiency, curves affording valuable information may be formulated.

Space will not permit a detailed discussion of still design, and so on, but it is noted in passing that the petroleum technologist is today radically improving old methods and design with such remarkable success that very attractive fuel saving is now an accomplished fact. Additional to this, we may anticipate with confidence still further improvement in this respect.

Another source of considerable fuel

(*Continued on page* 153)

(*Continued from page* 152)

loss in the primary distillation of crude oil is found in the quantities of steam introduced to the fractions. This is particularly so in the case of the shell still. Very few of them are equipped with instruments to indicate the quantities of steam introduced. What few instruments are used are usually simple mercury manometers read directly from a scale which measures the deflection of the mercury in the tube regardless of pressure. In such instances where even these simple instruments are not used, the steam is introduced through a throttled valve in conformity with the stillman's individual opinion.

THE methods and design of spiders or sprays to introduce the steam to the still also appears to be a matter of opinion in practically every instance. But all of the theories in this connection are more or less vague and incalculable.

Formulae covering the laws of partial pressure are available, and if this was the only consideration in connection with the introduction of steam, definite rules of procedure might be established in this connection. There is, however, the very important question of the mechanical condition of the still to be considered. Undoubtedly this type of fractionating equipment has inherent cracking tendencies which must be prevented, and this cracking tendency at times requires heavy quantities of steam.

On the basis of observation and tests conducted in a number of refineries, the author is of the opinion that the quantity of steam necessary to reduce the vapor tension of the fraction should also be sufficient to furnish the mechanical energy to agitate the oil, provided it is introduced through the sprays in a proper manner. Any quantity in excess of this amount is an unnecessary waste that requires heavier fuel consumption at the boilers to produce the increased volume of steam used, and extra fuel at the stills to furnish the heat required to raise the temperature of the excess steam to the temperature of the oil.

The common method of drilling the spiders or sprays is to locate the holes in such manner that the streams of issuing steam impinge on the bottom of the still at right angles to their flow. With such an arrangement, and dependent on the number of orifices in the spider, a proportional part of the hot still bottom is always kept bare of oil. The extent of these uncovered areas, in turn, is determined by the pressure maintained in the spider, the size of the orifice, its distance from the bottom of the still, and the static head of the oil. With such an arrangement turbulence alone is imparted to the oil and the effectivness of actual heat transfer per square foot of heating surface can only be surmised or approximated.

Experiments have recently been conducted whereby the rate of heat transfer per square foot per degree difference has been increased over fourfold by the introduction of a mechanical device directly into the oil, creating thereby a rapid circulation over the hot still surfaces. The effectiveness of heat transfer in the tube still also is obtained by means of rapid circulation.

Rearrangement of the drillings in the steam sprays, whereby both turbulence and circulation is imparted to the oil, have recently been made in the shell still, with considerable improvement noted. These experiments are not yet completed so that full information cannot be afforded at the present time.

* * *

From what has been noted in the foregoing paragraphs it is apparent that fuel loss which can be prevented may, and frequently does, occur in the average refinery. This may now be emphasized by a tabulation of the facts which have been presented and in each particular item noted, suggesting a means whereby a remedy may be obtained.

Fuel Loss No. 1—The Fuel Purchased

Remedy: Purchase the fuel from proven fields on a basis of the B.t.u. value and check the deliveries by frequent analysis.

Fuel Loss No. 2—The individual who burns his fuel.

Remedy: Educate him and supervise his activities.

Provide him with the proper instruments so that he may at all times be informed of what he is doing.

Pay him an adequate wage and a small percentage of the fuel cost he saves and then hold him to a strict accountability.

Fuel Loss No. 3—The boiler furnace.

Remedy: Determine that the grates are the proper type for the fuel that is burned.

If stokers are used, that they are in proper mechanical condition.

If fuel oil is burned, that the furnace is properly designed.

That suitable smokestacks of adequate size to carry off the hot gases are provided.

That all furnace settings are tight, in order to prevent unnecessary dilution of the hot gases.

That all furnaces are of an adequate size to properly support the combustion of the fuel.

That suitable dampers and controls are provided.

That systematic tests and records of flue gases are maintained as a check on operation.

Fuel Loss No. 4—The boiler.

Remedy: Determine that all heating surfaces, both external and internal are clean and kept so.

That all baffle work is tight.

That there are no steam or water leaks.

That boiler feed water is of a suitable quality.

That suitable automatic control is provided.

THAT all gauges, instruments, etc., are correct.

That daily records are faithfully kept and correctly calculated.

Fuel Loss No. 5—Steam distribution systems.

Remedy: Determine that all steam lines and other radiating surfaces not required for heating purposes are properly insulated.

That exhaust of steam to the atmosphere be avoided and applied to heating purposes where practicable.

That all condensate possible be collected and returned to the boilers as desirable feed water. instead of wasting it to the sewers.

That all steam control valves be tight and not leak when equipment is out of service.

That all branch or lateral lines be combined into one common main where possible, so that a multiplicity of small heat radiating connections may be avoided.

That heating requirements be correctly calculated and only sufficient radiation provided to maintain the desired temperatures under the prevailing weather conditons.

Fuel Loss No. 6—Still furnaces.

Remedy: Undertake the same procedure as has been noted in connection with the boiler furnaces and their operation.

Additionally, reduce excessive grate areas to a practical minimum that will afford the necessary heat for the purpose of fractionation without increasing the length of the still run or producing cracking conditions.

Fuel Loss—No. 7—Stills

Remedy: It would be a difficult matter to formulate a general rule of procedure covering the operation of all types of stills. At the same time, however, the installation of suitable indicating steam flow meters and some simple experiments in the quantity of steam introduced, will usually afford a profitable result. As before stated, every unnecessary pound of steam used is a fuel loss.

Fuel Loss No. 8—Steam sprays or spiders

Remedy: Determination that the sprays are correctly designed.

That the combined areas of the orifices do not exceed the area of the

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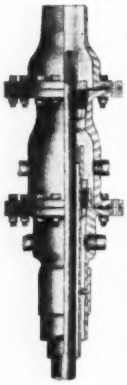

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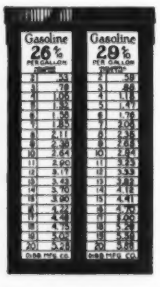

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lines supplying the sprays.

That the orifices are all open and that they are not unduly enlarged by the erosion of the steam.

Fuel Loss No. 9—Steaming out stills

Remedy: Closer attention on the part of the still operator to this important matter.

Fuel Loss No. 10—Heat lost in steam and oil vapors

Remedy: Suitable heat exchange equipment that will afford an opportunity to economically preheat colder materials.

Fuel Loss No. 11—Heat lost in escaping hot gases

Remedy: Hot gas recirculating apparatus.

Superheaters to increase the temperature of the steam.

Systematic gas analysis.

Insulation, etc.

Preheating incoming cold air.

Fuel Loss—No. 12—Loss of heat in avoidable rerunning—Steaming filters, sweating wax, etc.

Remedy: Proper evaluation of the importance of fuel cost on the part of every department executive.

It must be understood that the foregoing tabulations are only noted in a general way. A volume relative to any particular item could be profitably written and the subject not then be exhausted by any means.

In a recent review of tests conducted over a number of years, it has been found that industry in general is sustaining a tremendous burden of fuel loss. As an interesting side light on the refinery situation in particular, the following tabulation of losses in conformity with the previously itemized facts are submitted. These losses are founded on personal observations and are herewith stated in terms of preventable fuel loss. Item:

No. 1—Fuel	25%
No. 2—The fireman	50%
No. 3—Boiler furnace	25%
No. 4—Boiler	30%
No. 5—Steam system	40%
No. 6—Still furnaces	50%
No. 7—Stills	Unknown
No. 8—Sprays	Unknown
No. 9—Steaming	Unknown
No. 10—Steam and vapors	40%
No. 11—Hot gases	40%
No. 12—Supervision	Unknown

The items marked "unknown" are all determined to be potential losses, but just what they may amount to cannot be definitely stated.

Very rapid progress has been made within the past five years in the conservation of fuel in petroleum refineries. At the present time there are instances where the fuel bill has been reduced 50 per cent, meanwhile increasing the throughput considerably. Still greater saving is anticipated for the future in many cases as a reward of effort in this particular.

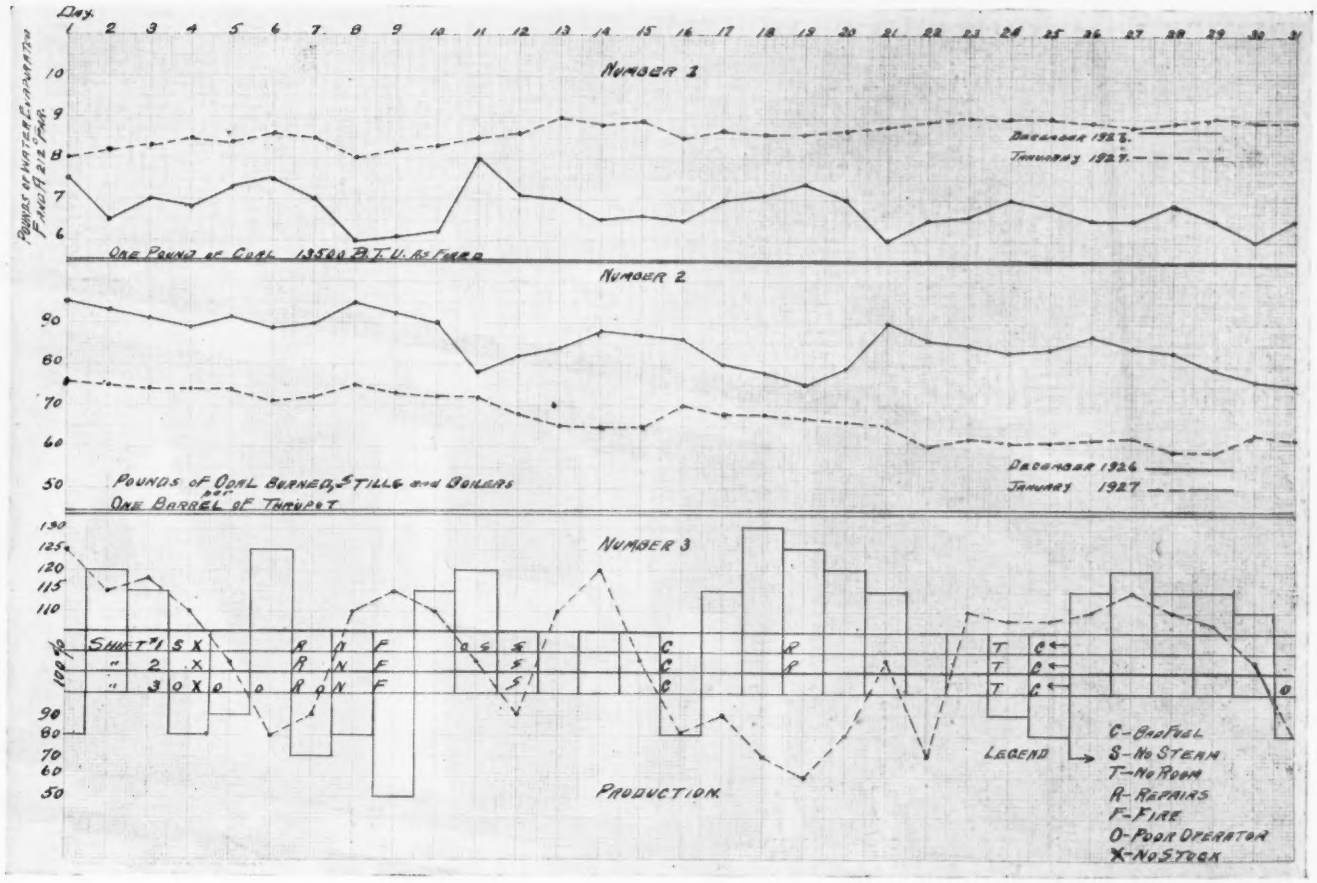
This raises the question—How can fuel loss be reduced? The answer is, by comparative systematic daily records, transferred in graphic form to the executive's desk and controlled from that point only, by placing responsibility where it rightfully belongs, and holding to a strict accountability the individuals directly concerned. Under such procedure it will not be very long before the executve himself—if he is a fair-minded individual—may learn that he is as badly involved in the situation as his men, and that had he provided some simple equipment, much waste might have been avoided.

Before any attempt is made to inaugurate a program of heat economies, it is very necessary that definite information peculiar to this phase of the refinery situation be available. This information is necessary in order that a basis for calculation may be obtained. First in order will be required information covering the fuel consumption, past and present, and the stocks produced. This is readily obtained from the accounting department. Next in order will be required, information pertaining to the physical condition of the equipment. Part of this can be obtained by inspection. The most important, however, must be secured by a series of tests conducted under daily operating conditions and in conformity with regular routine. Next in importance is the question of fuel which is being used, its cost and availability for the desired purpose.

After all possible information of this character has been obtained, the next logical step will be: first, purchase of suitable fuel, if that which is being used is not of the proper quality; second, modification of operating procedure as indicated by inspection; third, rehabilitation of such equipment as is indicated by survey, and finally, establishment of daily records faithfully and systematically calculated.

Within a period of 30 days after systematic record has been established, it will be possible to obtain summaries and recapitulation of daily performance. During the next 30 days, similar procedure will afford information which may be plotted in graphic form upon the preceding period's activities, and used as a basis for comparison in order to determine the progress made.

As total monthly records are obtained, these may in turn be plotted against records of previous months or years. Fuel consumption, boiler and still production, crude runs, filter yields, and in fact every phase of refinery operation, may be illustrated graphically, so that only a glance of the busy executive will afford him all of the information he requiries relative to a large part of any economic program which he may undertake.



Several typical charts are presented here.

Curve No. 1 graphically illustrates the progress of a fuel saving campaign conducted in a boiler room. Note that during December, represented by the solid lines, very irregular operating conditions, indicated by the peaks and valleys, prevailed. During January, represented by broken lines, the irregularities and their resulting effect upon general plant operation have to a considerable extent been eliminated. At the same time a greater quantity of steam has been produced per pound of fuel burned.

In curve No. 2, a graphic picture of economies obtained in curve No. 1 is reflected, by the reduced quantity of fuel consumed in processing a barrel of oil.

Illustration No. 3 is a picture of daily still production in graphic form somewhat different from curves 1 and 2. This tells the busy executive another important story without recourse to a mass of figures or reports. Note that the horizontal lines represent a normal, or 100 per cent, still capacity and also that there are three divisions, each one representing an eight hour shift. Blocks extended either above or below the horizontal or 100 per cent base represent the percentage of capacity produced for a particular day. Should it so happen that the desired capacity has not been obtained, the reason, represented by a letter, is noted in the center block and the time when trouble occurred approximately fixed by its location.

This graph, in effect, is a matter of task setting and accomplishment, with the cause for non-fulfillment plainly stated. Thus the story is unfolded day by day. Daily production of the previous month is represented by the broken lines and comparative information is thereby afforded.

The successful executive of today must know the "Why, How, and When" of his business. The graphs afford him the answer.

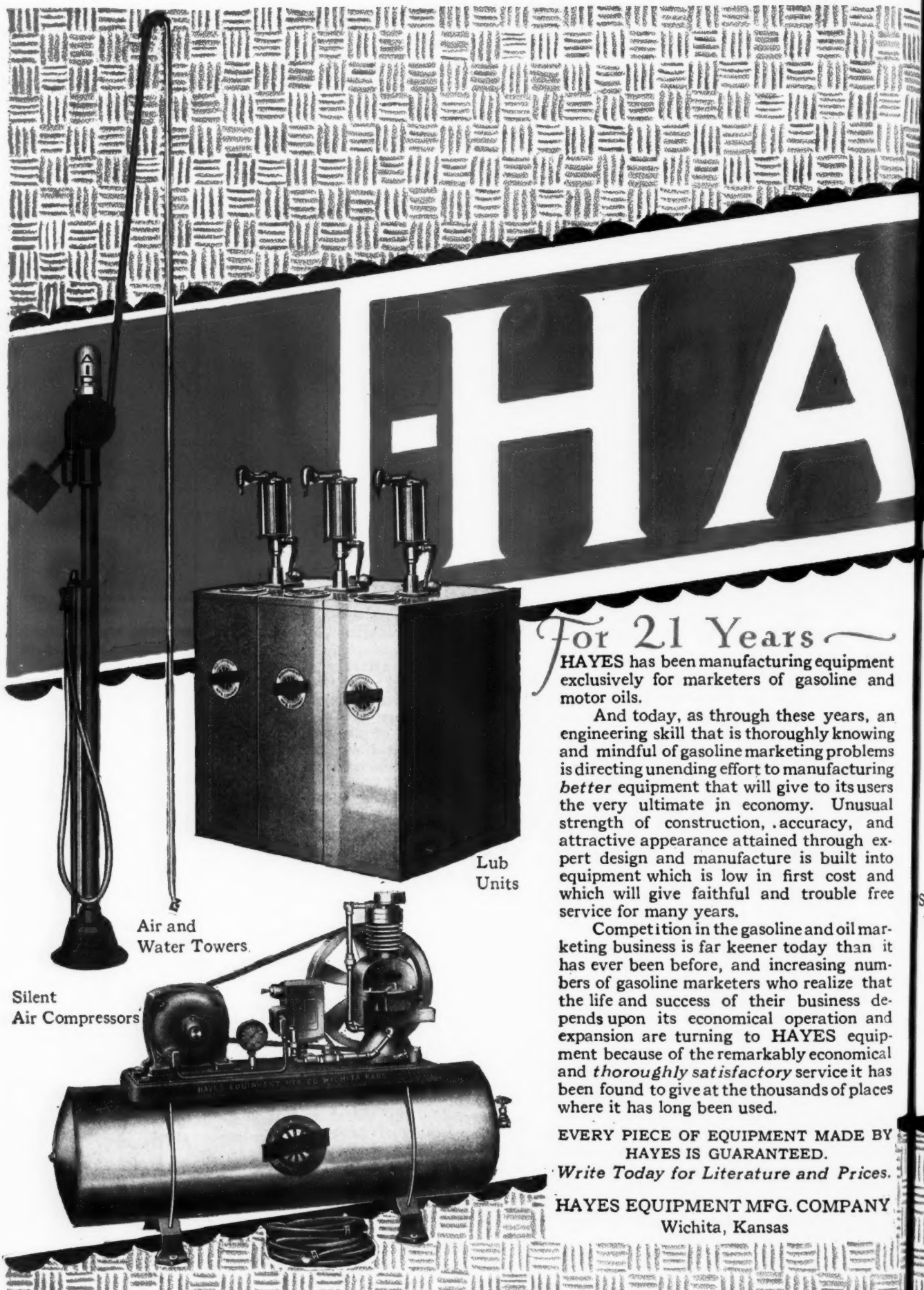
Illustrations of this character are essential to successful plant operation. Unfavorable or incorrect economic conditions are at once nipped in the bud and loss is avoided. The application of these graphic methods to plant operation are unlimited in their scope, and will be found a valuable aid to the executive who is really willing to shoulder his share of responsibility in order to conduct a thrifty enterprise.

It will require but a very short period of time after such records are formulated, to outline and also predicate a course of further fuel economic procedure. In the meantime, and during the progress of these activities in the foregoing particulars, it will be highly desirable to concentrate on equipment and place it in the best mechanical condition possible. It should be determined that boilers, stills, pumps, etc., are operating not only efficiently, but economically as well. It is an admitted fact that a lot of equipment has outlived its period of economic service and due consideration therefore must be given this fact. At the same time, very valuable apparatus in the refinery is today a liability rather than an asset, just because of careless operation, neglect, or the need of a few minor repairs. What it is desired to emphasize, is the fact that no expenditure for new equipment is warranted until all of the reasons for the failure of the old to function correctly are known.

PITTSBURGH—Blaw-Knox Co., manufacturer of steel products with headquarters at Pittsburgh, will move its New York offices to the Canadian Pacific Bldg., 342 Madison Ave., effective Oct. 1.

LOS ANGELES.—The Wade Engineering Co. with headquarters here, which handles products of The Lincoln Electric Co., Cleveland, O., has moved its northern California offices from 69 Webster St., Oakland, to 533 Market St., San Francisco. Need of increased space necessitated the change.

Tre Cutler-Hammer Mfg. Co., Milwaukee, Wis., has moved its Cleveland O., office from the Guardian Trust Bldg., to the Guarantee Title Bldg., suite 1905. Three times more space is obtained in the new location.



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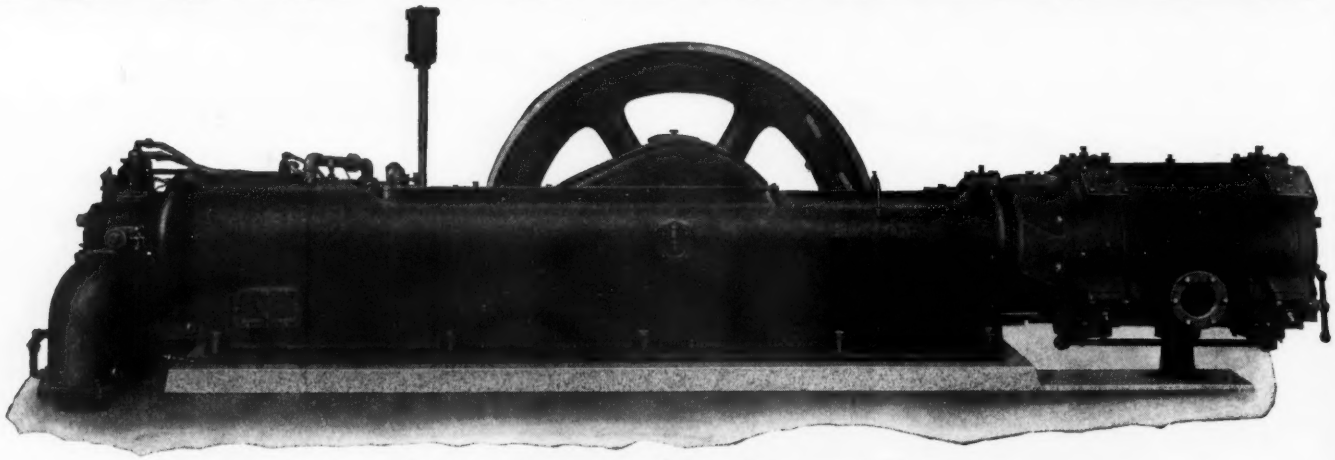

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Gas Combustion and Heat Problems In Oil Refineries

By B. P. Lientz*

THE cardinal factor in refining oil and obtaining a maximum yield of motor fuel, lubricating oil and other valuable products from crude oil is the proper and effective application of heat.

For more than a decade, I have studied the problem most carefully for the purpose of determining the relation of heat application to the refining of petroleum from the standpoint of the refiner.

Therefore, I have concentrated on the study of combustion of gas and liquid hydrocarbons and the application of heat particularly as it relates to the refinery and the processing of oil.

The Combustion of Natural Gas

EVEN though great strides have been made in the economic application of fuels and energy to the industries, the advance made in gas combustion has been characterized by slow growth.

The use of other fuels had become firmly established long before engineers could vision gas as a superior fuel, and its superiority is a reality only when its use is thoroughly understood and appreciated.

The fact that natural gas is being so universally used in refining processes speaks well of its adaptability for these purposes and a discussion of the elements entering into its combustion should be of interest at this time.

The composition of natural gases found in this country as given by the Bureau of Mines may be summarized as follows:

Composition of Natural Gases

(1) Source	CO_2	CH_4	C_2H_6	N_2	Specific Gravity Air -1	per cu. ft. Gross Btu.
Little Rock, Ark.	1.02	96.7	0.0	2.3	.57	977
(2) Bartlesville, Okla.	2.8	89.1	4.2	3.9	.62	987
(3) Los Angeles, Cal.	25.1	59.1	14.5	1.3	.88	843
(4) Buffalo	0.0	88.1	11.5	0.4	.61	1093
(5) Kansas City, Mo.	0.8	84.1	6.7	9.4	.63	967
(6) Charleston, W. Va.	0.0	76.8	22.5	0.7	.67	1172
(7) Oil City, Pa.	0.0	67.6	31.30	1.10	.71	1232

Methane, CH_4, predominates in natural gas while ethane, C_2H_6, forms the balance of the combustible. The inert diluents, nitrogen and carbon dioxide are present in small quantities, if at all.

The combustion of these gaseous fuels is simple if one understands their chemical reaction with the oxygen in the air when the mixture is brought to the ignition temperature. This temperature is that at which the heat evolved by the reaction just equals and therefore counterbalances the loss of heat consequent on the radiation and at which temperature the rapid combustion becomes independent of external supplies of heat.

The ignition temperatures of the constituents predominating in natural gas are within the following ranges:

For ethane and air 960 to 1160° Fahr.

For methane and air 1200 to 1375° Fahr.

These hydrocarbons require a definite minimum amount of air for their complete combustion and since this oxygen must come from the air in commercial operation, the amount of air so required becomes an important item in the combustion processes.

We will now consider the chemical reactions entering into the combustion of these two principal hydrocarbons in natural gas, determining the amount of oxygen required and therefore, the amount of air and the amount of resulting products of combustion.

In the combustion of one volume of methane there is required 2 volumes of oxygen which reacts to produce one volume of carbon dioxide and 2 volumes of water. The equation is $CH_4 + 2O_2 = 2H_2O + CO_2$.

The combustion of 1 volume of ethane required 3½ volumes of oxygen which reacts to produce 2 volumes of carbon dioxide and 3 volumes of water. The equation is $C_2H_6 + 3\frac{1}{2}O_2 = 2CO_2 + 3H_2O$.

To determine the volume of air required, it is only necessary to divide the oxygen volume by .209 as air consists primarily of 20.9 per cent oxygen and 79.1 per cent nitrogen by volume.

THE combustion calculations of a typical natural gas will be worked out to show the application of the above chemical reactions and having the analysis of representative gases in the composition table above indicated we will select gas No. 2 in this group for this purpose.

This gas we find to contain the following constituents in cubic feet per cubic foot of the gas:

CO_2	.028
CH_4	.891
C_2H_6	.042
N_2	.039
	1.000

The combustibles in this gas then are .891 cubic feet of methane and .042 cubic feet of ethane per cubic foot of the gas.

From the reactions of these hydrocarbons with oxygen we find that for 1 cubic foot of gas .891 cubic feet of CH_4 requires twice this amount or 1.782 cubic feet of oxygen and .042 cubic feet of C_2H_6 requires three and a half times this volume or .147 cubic feet of oxygen. The total oxygen therefore required for the complete and perfect combustion of one cubic foot of gas is the sum of the above oxygen requirements or 1.929 cubic feet.

We have found that air consists of 20.9 per cent oxygen by volume. Therefore it is apparent if we divide the total oxygen requirements by .209 we find that 9.25 cubic feet of air, approximately, are required. Furthermore, that the nitrogen accompanying the oxygen in this amount of air is represented by the difference or 7.03 cubic feet.

The products of combustion may likewise be determined from these chemical reactions as follows:

.891 cubic feet CH_4 produces one volume or .891 cubic feet of CO_2. It also produces 2 volumes or twice this amount or 1.782 cubic feet H_2O. .042 cubic feet C_2H_6 produces 2 volumes or twice this amount or .084 cubic feet CO_2 and 3 volumes or 3 times this amount or .126 cubic feet H_2O. The presence of CO_2 and N_2 in the gas have no active part in

*President B. P. Lientz & Co.

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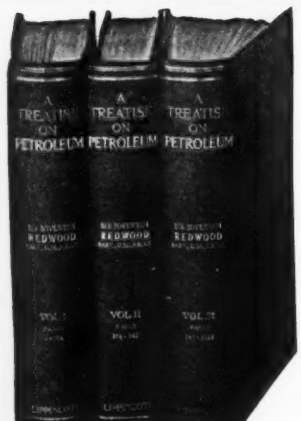

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this chemical reaction and are therefore inert.

Products of combustion will then be

	CO_2 cu. ft.	H_2O cu. ft.	N_2 cu. ft.	Total
From CH_4	0.891	1.782	.....	2.673
From C_2H_6	0.084	0.126	.....	0.210
Present in gas	0.028	.....	.039	.067
From air	.....	.....	7.300	7.339
Total	1.003	1.908	7.339	10.250

Total dry volume $10.250 - 1.908 = 8.348$ cu. ft.

WE HAVE therefore found that the combustion of one cubic foot of the natural gas selected requires 8.25 cubic feet of air and produces approximately one cubic foot carbon dioxide, 2 cubic feet of water and 7¼ cubic feet of nitrogen. These volumes are all at the same temperature and pressure as the original gas. It is convenient to measure them at 60° Fahr. temperature and atmospheric pressure for other temperatures and pressures correcting factors must be applied to determine the resulting volumes.

In order to make use of these volumes in determining the combustion process, it is convenient to express them in per cent of the total with the following results: We find that in the total dry products of combustion, namely, 8.343 cubic feet, there is 1.003 cubic feet of CO_2 and 7.339 cubic feet of N_2. Therefore, an analysis of the products of combustion will show 1.003×100 divided by 8.342 or 12.02 per cent CO_2 (maximum attainable) likewise 7.339×100 divided by $8.342 = 87.09$ per cent nitrogen, making a total of 100 per cent. These quantities are rarely, if ever, obtained as they represent the requirements for perfect combustion. However, with the proper equipment they can be very closely attained and an analysis of the flue gases or products of combustion is advantageous in determining the amount of air used and the volume of the products of combustion.

TO ILLUSTRATE: consider a flue gas analysis of the products of combustion of the above gas in which the per cent CO_2 is found to be 8 per cent. We have previously determined the volume of CO_2 in the dry products of combustion per cubic foot of gas to be 1.003 cubic feet, then if this now represents 8 per cent in our flue gas analysis, it follows that the total dry volume per cubic foot of gas burned must be 1.003 divided by .08 or 12.5375 cubic feet. Therefore, since air contains a definite percentage of oxygen (20.9 per cent) there must be a simple relation between the amount of CO_2 and the oxygen added by the extra air over that required for perfect combustion. Expressed in per cent it is as follows:

Per Cent CO_2 Analyzed

Per cent $O_2 = 20.9 - 20.9$ X per cent maximum CO_2 attainable

Then per cent $O_2 = 20.9 - 20.9$ X $12.02 - 7$ per cent

The balance or 100 — (8 + 7) or 85 per cent is nitrogen and the complete dry analysis would then be CO_2 = 8 per cent; O_2 = 7 per cent and N_2 = 85 per cent.

In order to determine the amount of air and therefore the per cent of excess air used in the above combustion, we must determine the volume of oxygen and nitrogen present. We cannot use the former for determining the per cent of excess air as some of the oxygen from the air combines with the hydrogen to form water which is lost in the analysis, inasmuch as the latter is on a dry basis.

However, all the nitrogen accompanying the air is present in the analysis and the determination of its volume will provide a means for finding the amount of air used. We therefore proceed as follows:

The volume of nitrogen is equal to .85 times 12.5375 or 10.672 cubic feet and since air contains 79.1 per cent of nitrogen per volume, the volume of air therefore must be 10.672 divided by .791 or 13.491 cubic feet but since only 9.25 cubic feet of air is required for perfect combustion of this gas per cubic foot then for 8 per cent, CO_2 gas analysis the excess air is

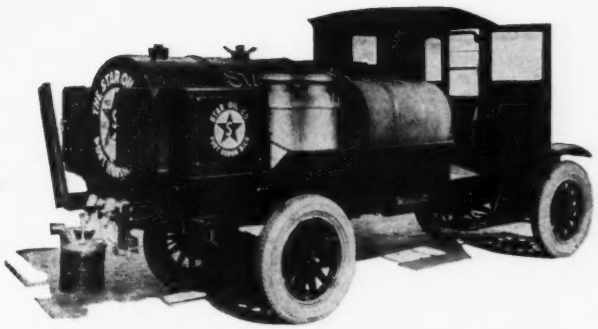
$$\frac{(13.491 - 9.25 \times 100 - 45.84 \text{ per cent}}{9.25}$$

IN THE foregoing discussions we have considered the chemical reactions as absolute in their natures resulting in final products proportionate to the initial concentrations of the materials present. However, in actual practice it soon becomes apparent that they do not correctly answer certain problems involved of which the most important probably are those relating to the calculation of flame temperatures.

In the combustible mixture considered certain combinations take place at some definite point of temperature and partial pressure, and when chemical action ceases the mixture is said to be in chemical equilibrium. However, this equilibrium can and may be displaced by further changes in temperature and pressure.

It is apparent then that at the highest temperatures produced by combustion these reactions have not proceeded to completion and the presence of "free" combustibles will continue until the temperature has been lowered. In practice, this takes place at the very edges of the flame in the invisible envelope of hot gases surrounding the flame wherein the combustion is completed to a stable equilibrium.

The entire combustible is finally consumed but not in such a way as to make available all the heat of the reactions to produce a maximum flame



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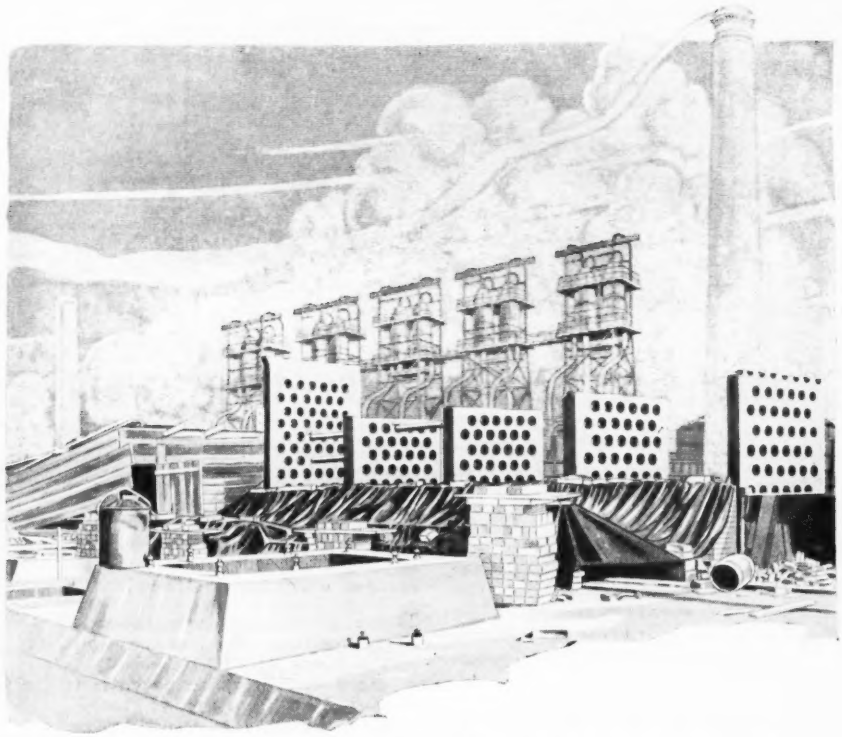

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temperature. This condition is caused by the dissociation processes going on during the elevation of temperature and while their extent is not definitely known, it is universally conceded that this dissociation places insurmountable difficulty in the attainment of high temperature combustion in preventing the flame temperatures from rising to the calculated intensities which, except for these processes would be easily attainable.

In the combustion of the principal hydrocarbon in natural gas, namely, methane with a net heating value of 916 B.t.u. per cubic foot, the calculated uncorrective flame temperature is 3763° Fahr. when complete combustion is carried on with the minimum amount of air required at 60° Fahr., but when corrected for the dissociation of carbon dioxide and water vapor in the chemical reactions outlined the flame temperature is lowered to 3630° Fahr.

This temperature of 3630° Fahr. represents the maximum obtainable with just the proper amount of air for combustion and without any losses due to radiation. It is a theoretical maximum. It is, however, possible to increase this temperature by an external source of heat such as that brought in by preheated air. However, in practice radiation from the flame and excess air accompanying the air from combustion lowers the flame temperature considerably.

The discussion of flame temperature is important in high temperature processes for determining the selection of a gas which will produce the highest temperature; however, in refinery processes we are not interested so much in the maximum flame temperature obtainable as we are in securing the maximum heat at lower temperatures per cubic foot of gas burned.

Heat Application

THE transmission of heat to a body is of such commercial importance that great care should be taken in the adaptation of the predominating mechanism of heat transmission employed in individual cases. In the treatment of oil from the refiner's standpoint the transmission of heat should be accompanied as far as possible by employing means to provide for the application and transfer of heat primarily by conduction and convection.

There are several factors entering into this heat transfer. There must be a temperature difference between the medium supplying the heat and the medium receiving the heat to cause a sufficient heat flow.

The resistance to this flow of heat must be reduced to a minimum in order that this temperature difference may be maintained effectively. The

extent of these requirements is dependent upon the ability of the receiving medium to absorb heat and to the economic means available for overcoming the resistance to heat flow.

Refinery processes are carried out scientifically on a temperature pressure basis either alone or together and while the latter varies through a wide range from low to high the former varies only from low to medium, so that between the high temperature of combustion and the low to medium temperature of our processes there is a large gap to bridge.

Bearing in mind then that these processes are carried on in a medium temperature plane, it is desirable to know how the combustion gases may be conditioned so that their temperature is reduced to the working range. This has been accomplished by increasing the air supply to the fuel from 200 to 400 per cent above that sufficient to meet the requirements for combustion.

This produces complete combustion, a lowered temperature in the combustion gases and the large volume of potential heat so desirable.

This large volume of gas in passing around the oil, vaporizes with appreciable velocity and reduces materially the resistance to the heat flow caused by the film of gas immediately adjacent to the vaporizers. The cooling of the combustion gases in this manner appeared to satisfy both requirements for the heat flow until it was developed that there were available more economic means for accomplishing the same results and which has since proved to bring about results unattainable heretofore.

WE KNOW that at best about 30 per cent of the heat originally contained in the fuel is lost in the flue gases. This necessarily must be so as the temperature gradient between the products of combustion and the oil in the vaporizers must be maintained to produce the thruput and yield desired.

The development of a recirculating system for utilizing this waste heat has reduced this loss by returning to the combustion and the vaporizer chambers from 85 to 90 per cent of the sensible heat passing out to the stack. This operation was previously explained as published in the NATIONAL PETROLEUM NEWS January 19, 1927, issue entitled "Recirculating Gases Saves Fuel and Reduces Maintenance in Still Furnaces."

The initial purpose of recirculating the hot flue gas was the replacement of the excess air for combustion, permitting the use of higher temperatures of combustion but cooling and diluting them with the spent flue gases in place of the comparatively colder air. That this was successful from a fuel saving standpoint cannot be denied, the return of such high percentage of waste heat was a decided economic step.

In the recirculating system further possible advantages were developed. A valuable function, although of lesser importance, that of preheating just the amount of air for perfect combustion by the final waste gases, was found to be a disadvantage from a practical operating standpoint. To be sure, higher initial combustion temperatures were desired and obtained, permitting and necessitating a large return of waste gases direct to the vaporizing chamber, but difficulties arose with refractories comprising the combustion chamber.

THE reduction of the excess air, together with the preheat in the air actually supplied increased the temperature of combustion to a point approximating the melting points of the refractories or to such an extent as to cause a decided weakness in their structures. To reduce this hazard more air was supplied and in sufficient quantities to lower the combustion temperature within a safe working range of the refractories present.

As a result an improvement was noted in the thruput, the lower temperature gradient on the "fire side" of the vaporizers and the higher temperature gradient on the gas exit side of the vaporizers. Where heretofore without recirculation this difference was from 3 to 4 times as great on the fire side as on the exit side, it is with this system only from 1½ to two times as great.

This has resulted from reducing the temperature of the combustion gases on the fire side and raising them on the exit side. From a gas temperature standpoint, whereas the "spread" or reduction of the temperature of the gases between the fire side and the exit side has been formerly from 550° to 800° Fahr. it is with this system from 250° to 500° Fahr. through the use of increased volumes made available both in the recirculation of the flue gases and the preheating of the air for combustion.

The recirculating system provides means for handling large volumes of hot gases, for the heat exchange between the flue gases and air in metal recuperators, for the proper and effective introduction and mixing of the recirculation gases and the products of combustion and for the correct and economic combustion of the fuel by means of a combination oil and gas ignition system which permits the burning of either fuels together or separately with equally high efficiencies.

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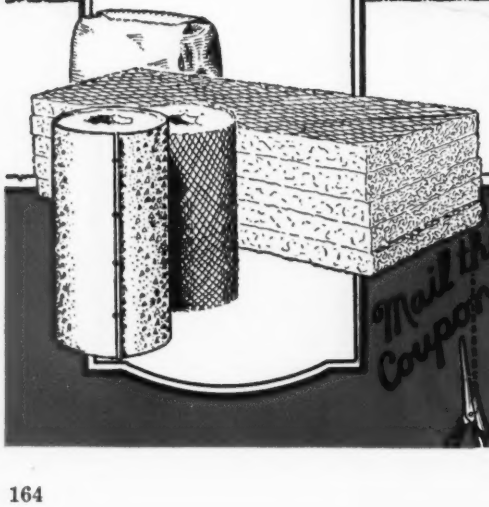

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A Step or Two Forward in Construction Of Pumps for Handling Hot Oil

By J. E. Sitler*

AS REFINING processes become more and more intensified, more and more is expected of the pumps. Little consideration is given to the pumps by process inventors; rather they look to pump manufacturers to meet conditions.

In the last few years long steps forward have been made in the cracking industry, and at the same time a higher temperature meaning has been given to the term "hot oil." This has called for something very unusual in pump design—pumps capable of pumping hot oil around 1000 degrees Fahr. and to 1500 pounds pressure and more.

Not so very long ago, the term hot oil was interpreted as meaning oil around 300 or 400 degrees Fahr. Even at this relatively low temperature trouble was experienced with ordinary pumps due to expansion of the fluid end. Undue expansion caused cracked fluid cylinders and valve decks; it caused pistons to stick in cylinders and rods to stick in the packing.

Different measures were taken by different pump manufacturers who had interested themselves in this work, to overcome these difficulties.

One manufacturer was quite fortunate in having a pump which had been designed for handling hot tar, residuum and other hot products in refining. Many of these pumps had then been in service 20 to 30 years. With a few changes here and there, they were found to be perfectly adapted to the new service of pumping hot oil. On account of their peculiar shaped fluid valves, they had been named block valve pumps.

THESE pumps have proved so effective and popular for medium temperature hot oil work that it is felt they deserve description in any article on handling hot oil.

The cylinders are cast separately, and so made that trouble due to expansion is eliminated. The liners are solidly bolted in place by set screws and lock nuts.

The rectangular valve is unique and eliminates the use of troublesome valve guards, stems, springs, separate seats and plates.

Each valve is a box casting open at the top and so designed that distortion from any cause is practically eliminated.

Valve seats are integral with the cylinder casting and are raised about ¼-inch. This permits refacing when necessary. The valves and seats,

J. E. SITLER

however, wear for a great many years before needing any attention.

Later, the manufacturer of these pumps experimented with cast steel fluid cylinders and recommended this construction for his pumps when conditions called for 300 pounds working pressure. When pumps were specified to handle hot oil up to 400 and 500 degrees Fahr. extra deep stuffing boxes containing lantern glands were also added as a precaution against stuffing box leaks. The longer rod packing also decreases the amount of pressure necessary on the packing, cutting down the wear of both packing and rod. The deep stuffing box and lantern gland are described later in this article.

In the meantime pump manufacturers catering to the refinery trade were becoming more and more familiar with the general subject of cracking processes, and particularly with the pumping of hot oil. The experience thus gained by actual contact with the hot oil pumping problem was invaluable to these manufacturers in the next step forward.

PROCESS inventors and designers were bringing out new ideas to increase the efficiency of their installations, and the temperature and pressure of the oil went away up in most cases. When the specified oil temperature went over 500 degrees Fahr., and the working pressure over 300 to around 500 pounds, it was realized that something would have to be done to meet conditions. The safety limit of cast iron and cast steel had been passed.

A cast steel fluid end, while satisfactory in every other way, might contain an invisible flaw here and there, which the permeative action of the hot oil would be sure to locate. So, therefore, castings could not be guaranteed, and it was decided to make fluid cylinders from solid steel forgings for safety's sake.

Much consideration was given to safety throughout the entire pump, because at this temperature any leak of the hot oil meant a flash, and a flash meant possibly an accident to an employee or a refinery fire.

In order to prevent any possible leakage at the piston rods, a very deep stuffing box was designed and attached to each pump cylinder, so deep that the hot part of the rod never runs up into the packing, much less into the open air. This stuffing box is provided with a water jacket and the course of the water through the jacket is directed by means of a spiral fin around the stuffing box, so that the maximum cooling is obtained for a minimum amount of water.

The arrangement is very effective in cooling the rods, so much so that you can put your hands on either fluid piston rod while running, without discomfiture. The rod is actually cooler on the pump end nearest the stuffing box than it is up next to the crosshead.

THE jacket wall of this stuffing box is not welded in place but is bolted at the end nearest the cylinder, and at the outer end it is packed off with a few rings of packing in a screwed stuffing box, so that from time to time the outer wall may be removed and the jacket cleaned of any deposit of mud or other sediment that may be in the jacket water. This removable jacket is a very distinct advantage.

In addition to the long rod fit and deep stuffing box, a lantern gland is provided to further insure that there will be no leakage of hot oil into the air.

Any possible leakage of hot oil past the packing, strikes the lantern gland, where the pressure is released, and the oil is piped off to the suction again. Lastly, the lantern gland itself is held in place by several rings

*National Transit Pump & Machine Co.

of packing. With this arrangement you are insured that there will be absolutely no hot oil escape into the air to take fire. Different pump manufacturers employ different methods of packing the piston rods.

It is common knowledge that during the run of a batch of oil, a pump breakdown or shutdown might prove disastrous. There must be some effective guard against this rather remote possibility.

Many hot oil pump manufacturers use the "spare" idea to insure continuous pump operation. That is, an extra pump of equal capacity to any other of the hot oil pumps is recommended. Generally this extra pump is kept in operation and a slow speed, easy running and consequently long-lived installation is the result. When it is necessary to shut down one of the hot oil pumps, the capacity of the remaining pumps or pump is sufficient for the needs.

THE steam end of the single steam pump is fitted with an improved steam valve gear, positive in action, no dead center and no short stroking. Tie-bar construction cuts down the weight, and renders the stuffing boxes easier of access.

Single reciprocating pumps, on account of their low cost lend themselves to this work very well, the only possible drawbacks being the high cost of piping, lack of close control and their tendency to produce shocks in the lines. Each pump requires a separate suction and discharge line and this costs money.

In installations where two or more single pumps are necessary the question of control enters. It is desirable in pumping hot oil through cracking coils to have the flow as even and uniform as possible. Two or more single pumps operating on the same line might reciprocate in unison and defeat this desirable condition. That is, all pumps might make their forward strokes at the same time, and their backward strokes at the same time. This would give heavy pulsations on the discharge line, and an uneven flow of oil. Continued heavy pulsations might start a leak in the hot oil discharge line.

To secure the above advantages inherent to single pumps and at the same time overcome the disadvantages, one manufacturer conceived the idea of placing two single hot oil pumps side by side, on the same foundation and timing the function of each pump by a synchronizing device. This device is very simple and is part of the valve motion of the pumps. Throwing the control to the left, when standing at the right-hand side of the pumps, causes the pumps to operate independently, or as two singles. While operating in this manner, it is easy for the operator to determine the pump in trouble, and shut it down by a simple movement of the synchronizer control. All this is but a matter of a few seconds. Immediately on shutting down either pump, the other pump automatically doubles up both in speed and capacity.

THROWING the synchronizer control to the upright position stops both pumps practically instantaneously, without touching the throttle valve.

In an emergency with compound pumps, live steam can be admitted to both the low pressure and high pressure steam cylinders at the same time. Thus, with a very much reduced steam pressure, the hot oil pressure can still be kept where necessary.

The fluid cylinder liners are of cast iron pressed in. Some steel manufacturers are quite enthusiastic about alloy steels for this service, but in the light of present experience, cast iron seems to be satisfactory.

Fluid pistons are of cast iron. Each piston is equipped with two sets of cast iron three-ring packing, separated by a spacing ring.

Gasket grooves are machined in both ends of each cylinder, one-half the width of the groove in the cast iron liner and one-half in the forging. In these grooves, sheet aluminum gaskets are inserted and the tongued cylinder heads pulled up tight against them. The soft sheet aluminum gasket will accommodate the little expansion and contraction certain to occur, and the joint is simple and easy to make or break. All fluid joints are tongued and grooved and gasketed as above.

IN SOME localities, the cost of steam is all out of proportion to the cost of power by an internal combustion engine or electric power. For such installations, the vertical triplex power pump is commmended. Aside from the low cost of power, these pumps have several advantages not found in other types, and it is believed that they are destined to become very popular in hot oil work.

(a) The floor space is so small that these pumps can almost always be located in the most advantageous place. Installation economies result from the small foundation necessary and from the reduced cost of piping.

(b) The weight of the fluid plungers is suspended vertically from the crankshaft, thus relieving the packing of this weight. Result: long wearing packing and long wearing plungers.

(c) A valuable feature is the very fact that it is a triplex. Three fluid cylinders insure that pulsation is reduced to the minimum, and a very uniform speed of hot oil through the cracking coils is obtained.

(d) Each stroke of a power pump, pumps so much every time. This means an exact capacity per minute, per hour, and per day.

In other words the capacity is unvarying.

THE power or drive portion of this pump is very strong, and is similar to tried out designs which have been operating in the heaviest services for many years. A broad faced herringbone gear of cast steel, and a pinion of forged steel eliminates practically all gear noise and vibration. The fluid end is, of course, machined from a solid forged steel billet.

The suction valves are located between the discharge valves and the plungers. Each suction and each discharge valve has its own separate cover, easily removable.

The fluid plunger stuffing boxes are extra long and water cooled. On this pump, these boxes are first screwed into the fluid cylinder forging and as an additional safety measure are then welded tight into place. On the rear of this pump, the fluid cylinder forging has three hand hole covers, the removal of which permits access to the interior for the extraction of coke and for cleaning.

These pumps are in the high pressure class, capable of pumping 170 barrels per hour against 1050 pounds pressure. Maximum temperature of hot oil is 750 degrees Fahr.

The most recent developments are embodied in a pump made for conditions of service the highest in pressure and temperature that are ordinarily encountered in hot oil work. The fluid end withstood a test pressure of 4000 pounds and is guaranteed to operate continuously at 1500 pounds pressure. The outfit with only 100 pounds steam will pump against 1000 pounds fluid pressure. Maximum temperature of oil 1000 degrees Fahr.

The fluid cylinders are of special analysis forged steel very similar to the fluid cylinder already described. A liberal number of handhole plates is provided to facilitate inspection of the valves, cleaning and for the removal of coke from the fluid passages.

Each end of each fluid cylinder is equipped with a water cooled stuffing box, similar to the one already described, except that the stuffing boxes on these pumps are cast iron lined to remove the possibility of any scoring or cutting between the forged steel fluid plungers and stuffing box throats.

Crosshead slides carry the weight of side rods, crossheads and fluid plungers, thus relieving the stuffing box packing of this weight.

HEAVY, substantial cast iron steam piping and reliable globe control valves on the steam end are features we point out. This means simple and positive control, and it means safety, rigidity and strength. There is no compromise with safety.

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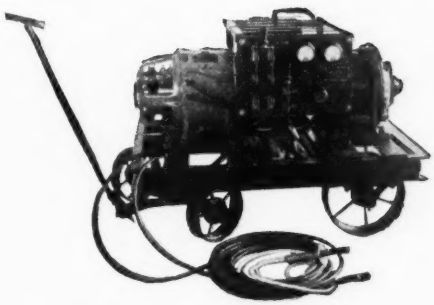

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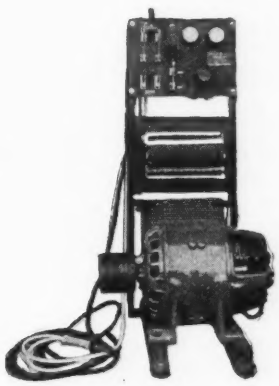

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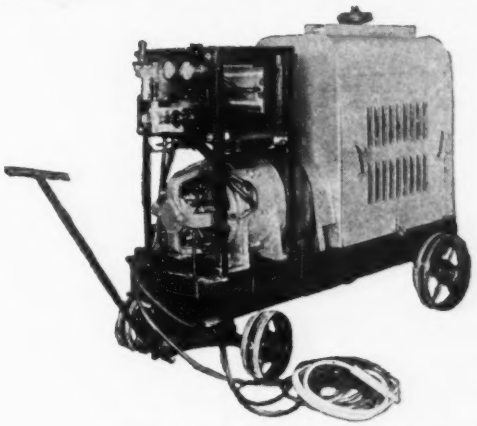

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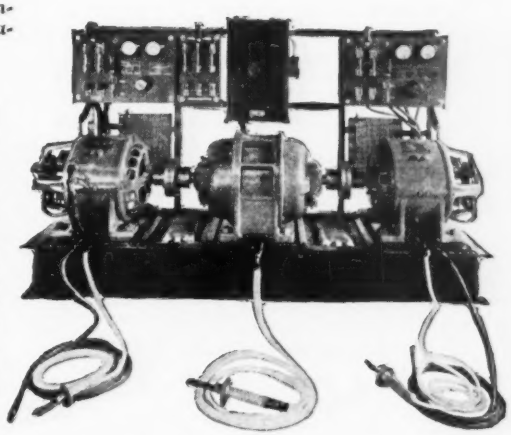

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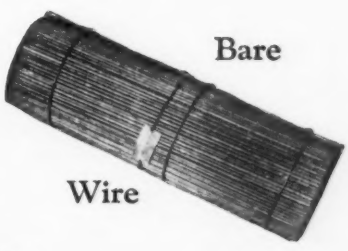

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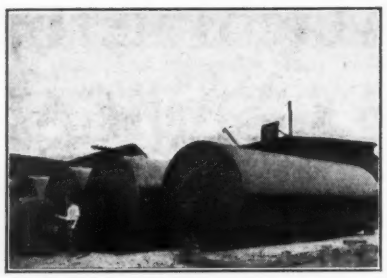

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ONE-GALLON PUMPS

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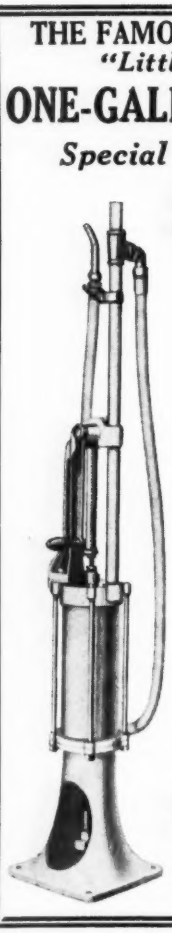

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Brass cylinder and heavy castings built for long service. Equipped with quart and half gallon stops, 8′ hose or can nozzle, locks foot valve. Built to the highest standards of the famous Shotwell BALL-BEARING line. Shotwell is the original — beware of imitations.

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Probably the most interesting feature of this design is the automatic synchronizer which controls the cycle of each unit of this twin pump, and also, in case of a breakdown on either side, cuts off the side in trouble and causes the opposite side to operate at twice its normal piston speed, and thus carry the full load.

The valve motion of one pump is actuated by the action of the other pump and vice versa, something like the ordinary duplex pump. In addition to the regular steam valves for each single pump, the steam admitted to each cylinder is first controlled by individual cut-off valves.

The automatic control is by means of a Mason governor and a balanced valve. In case one pump, for any reason, should stop, the Mason governor automatically opens a throttle valve to an auxiliary steam cylinder, and this in turn throws the throttle valves on both single pumps wide open, and the single pump which is in running condition will operate as a single pump, automatically taking care of the capacity of the twin unit at twice its normal piston speed.

The ordinary duplex pump has a certain swell at the end of each stroke before the other side of the pump begins its stroke, but with this synchronizing arrangement, at the same time the plunger on either side reaches the end of its stroke, the plunger on the opposite side begins its stroke. Result: a much more even discharge than is ordinarily obtained from a duplex pump.

The selection of pumps for hot oil service is an engineering proposition. It is not merely a question of obtaining the correct size of pump.

Prospective hot oil pump purchasers we believe, will do well to take their particular pumping problem up with the pump manufacturer for suggestions and recommendations.

Although outside of the scope of this article, it might be well to call attention to a point that is sometimes not given the attention it deserves. That is, the lay-out of the suction and discharge piping to and from hot oil pumps. In most installations, successful pump operation depends on this factor more than is generally realized. It is an important point to keep in mind.

In an article of this kind, it is always customary to take a look into the future.

What of the future? How high will working pressures go? Will corrosion make a new fluid end material necessary if the temperatures go much higher? Which will be the best type of hot oil pump?

These are questions which only the future can answer.

Much pioneering work has been done and much money has been expended in experiments by the different hot oil pump manufacturers in their efforts to meet conditions. And they have been successful. All efforts have been concentrated on developing the particular type of pump they feature, so that today, good, reliable hot oil pumps can be purchased from more than one manufacturer.

Furthermore, it is my honest conviction today, that sometime in the future when the hot oil pump problem is altogether solved, seeral different types of pumps by several manufacturers will bear the stamp "O. K.".

National Recording Stock Sold by Inactive Holders

DAYTON, O., Sept. 17.—A large block of capital stock of the National Recording Pump Co. with headquarters here, was recently purchased by a syndicate of bankers headed by Westheimer & Co., member of the New York Stock Exchange and other stock exchanges, and N. S. Talbott Co., Dayton. The stock purchased was common stock held by inactive stockholders and was not sold by the company itself.

The public offering of stock on Sept. 1 was a matter of record. No change in management, policies nor company members has been made, except that J. P. Hanna, formerly vice president in charge of the business during most of the past three years, has been elected president, and that S. W. Burnham is now chairman of the board.

Convertible stock was offered for subscription at $36.25 per share. It has been listed on the Cincinnati Stock Exchange where recent sales have been around $39 and $39.50 per share, according to Mr. Hanna.

The company's total stock consists of 45,000 shares of convertible stock and 45,000 shares of managers stock, with an additional 45,000 shares reserved for future conversion of the convertible stock at the holders' option.

The company has no bonds, mortgages or notes outstanding. Its current assets are more than eight times its current liabilities, Mr. Hanna states. Both gross sales and net profits for the first eight months of this year were the greatest on record in any similar period.

CINCINNATI, O.—The Cincinnati Ball Crank Co. will manufacture all high pressure guns and other high pressure lubrication units under patents of the Bassick Mfg. Co., it has been recently announced.

The Balcrank type "D" high pressure lubricator and its line of high pressure nipples will be made under this license, in addition to Balcrank patents.

Soaking Drums Cleaned Mechanically By Rotary Drilling Method

By H. W. Fletcher*

AS THE consumption of gasoline increases, the importance of the cracking process to the petroleum industry becomes correspondingly emphasized. The petroleum molecule is a complex structure built up of carbon and hydrogen atoms in various amounts. The relative number of carbon and hydrogen atoms in the molecule determines the characteristic of the compound; that is, whether it will be gasoline, kerosene, or heavier oil.

Most crude oils contain some gasoline which can be separated from the rest of the liquid by boiling at a low temperature and condensing the vapor, but in many cases the percentage of the gasoline originally in the crude is comparatively small.

Fortunately, it was discovered that these complex molecules of the heavy oil could be broken down by the application of heat for considerable periods, evaporation being prevented by keeping the liquid under high pressure. Breaking down a given molecule in this way produces molecules both lighter and heavier than the original, and if carried far enough will result in the liberation of some solid carbon. As a result of this most ingenious process the greatly desired relatively light gasoline molecule can be "manufactured" from the heavy molecules of a crude originally containing practically no gasoline, and the industry has thereby been enabled to keep pace with the tremendous increase of gasoline consumption without a corresponding increase in the production of crude oil.

THE production of solid carbon is an undesirable result of the cracking process as this carbon deposits in the form of coke inside of the cracking equipment, gradually filling up the space and requiring the cracking equipment to be periodically shut down and the coke deposits removed.

Time being an essential factor in the cracking process, large chambers called "soaking drums" are provided in which the oil is maintained under a high temperature and pressure for a considerable period. These drums are often from 6 to 10 feet in diameter and 30 to 45 feet high, and may become filled with coke with greater or less density to a height of 20 to 30 feet.

It has been the practice in the past to hang a length of steel cable on small brackets inside the drum, winding it in a spiral from the bottom to the top of the drum, and consequently leaving it embedded in the coke when the run is completed. When the drum is shut off, has been steamed to remove combustible gases, and has cooled down sufficiently, the lower manhead is removed and this cable is dragged out with a tractor or hoisting engine and tears a considerable portion of the coke loose.

It is then necessary to send men into the drum and finish cleaning by hand.

This cleaning system is rather unsatisfactory since it requires from 6 to 12 hours to cool the drum down sufficiently so that men can work in it, and the operation is very dusty and somewhat hazardous because of the danger of flashing of inflammable vapors from adjacent drums in operation. The actual expense of labor for cleaning is not so important, but the loss of productive time of the equipment is considerable, amounting in some cases to from 10 to 25 per cent of the total operating time.

THE problem of coke removal from soaking drums was of particular importance at the Baytown refinery of the Humble Oil & Refining Co., because of the large number of drums in service. The company decided to undertake the development of a mechanical cleaner for this purpose which would permit cleaning of the drums at higher temperature and perform the operation in less time, thereby reducing the lost production time during the cleaning operation, and called on the Hughes Tool Co., of Houston, to design and build the equipment.

It was decided to drill a hole upward through the coke, leaving a fairly thick layer adhering to the walls of the drum, and then in a second operation to remove this layer by beating it off with small bronze disks attached with chains to the top of a drill stem, the drill stem to be raised and lowered by hydraulic pressure and to be rotated by a small portable steam driven rotary.

The hydraulic cylinder illustrated in Fig. 1 consists of approximately 75 feet of 12½-inch casing set in the ground directly under the center of each soaking drum. Inside of this casing hangs a string of 10-inch casing about 66 feet long supported at its upper end on a bradenhead making a fluid tight joint on the 12½-inch casing.

The bottom end of the 10-inch casing is perforated and means are provided to introduce water under pressure between the 12½-inch and 10-inch casing at the surface. Inside the 10-inch casing is a piston on top of which rests the thrust bearing and drill stem, the latter being approximately 57 feet long for a 40-foot drum. When water pressure is admitted under the piston it raises the drill stem, and when water is allowed to discharge from the cylinder the weight of the stem carries it down again.

The drill stem consists of 3 lengths of 31-pound drill pipe welded together at the ends and provided with four driving ribs spaced 90 degrees apart, made of flat steel 1-inch by 2-inch, and welded to the pipe the full length of the stem.

The rotary unit consists of a structural steel frame mounted on wheels running on a narrow gauge track on which are supported a 6-cylinder Baker rotary steam engine of approximately 25 H. P. direct connected through a flexible coupling to the pinion shaft of the rotary. The rotary is of all steel construction, runs on ball bearings, there being seventy 1½-inch balls in the table bearings, and is driven through replaceable heat treated cut gears. All moving parts are fully enclosed to prevent entrance of coke dust which would otherwise rapidly destroy the bearings.

THE initial hole is drilled with a fish tail bit dressed to a diamond point for better centering and provided with two reaming arms producing approximately 36-inch hole. These arms are collapsible so that they may be entered through an 18-inch manhole opening.

The second operation is performed with a bit as illustrated in the upper right hand corner of Fig. 1. This bit has three hinged arms arranged to pass through the manhead and then open out, and on the end of each arm are two bronze disks carried on separate lengths of chain. When this bit is rotated, centrifugal force throws the disks out to the circumference of the drum and they rapidly beat off the layer of adhering coke.

The first step in the cleaning operation is to cut the drum off the line and steam it to remove inflammable vapors. The manheads are then removed and steaming continued. A small stream of water is also sprayed in which helps to cool the drum and the hand wheels on the frame are unscrewed allowing the dowels shown in

*Chief engineer, Hughes Tool Co.

in cut below to enter steel sockets set in the correct position in the concrete. This accurately aligns the center of the rotary with the center of the hydraulic cylinder and of the soaking drum.

Water pressure is then admitted to the cylinder and the drill stem is raised through the rotary table and the driving bushings put in place. The fish tail bit is then screwed on to the top of the stem, the reaming arms are collapsed and the stem is slowly raised until the bit reaches the coke just inside the manhole. The stem is then rotated slowly, from 10 to 20 revolutions per minute, and as it is fed upward the bit cuts away the coke and the reaming arms expand to their full diameter. The coke cuttings pour down from the manhead and on to the rotary table which is enclosed in a stationary sheet steel hopper provided with an opening in one side and a small chute leading down to a pneumatic conveyor.

CENTRIFUGAL force throws the coke toward the rim of the rotary table, where a series of paddles attached to the rim drive it around the hopper and eject it through the chute into the conveyor, which carries it to the bins in the boiler house or to the stock pile as desired.

When this first hole has penetrated through the upper surface of the coke the drill stem is lowered, the fish tail bit is removed and the disk beater is attached to the stem. The arms of this second bit are then collapsed and it is introduced through the manhole and the arms drop down into position. This bit is rotated at from 60 to 65 R.P.M., and the disks are thrown by centrifugal force against the coke still adhering to the wall. This coke is, of course, discharged from the rotary to the conveyor just as in the first operation.

The actual rate of drilling in the first operation in a 6-foot drum may be as high as 2 feet per minute, depending, of course, on the hardness of the coke, while the second operation may reach 3 feet per minute. The over-all time for a complete cleaning operation on a 6-foot by 40-foot drum will average from one hour to one hour and a half, while a 10-foot by 45-foot drum has been cleaned in five hours. This corresponds to a reduction in actual cleaning time of from 70 to 90 per cent with a reduction in the shutdown time of from 60 to 70 per cent as compared with the old method of pulling with a cable and finishing by hand. In addition, the operation is very much less hazardous, as it is unnecessary to send men into the drum at any time in the process.

Some three years has elapsed since the initial experimental runs, and the equipment has been in constant routine service for more than two years at Baytown, justifying the conclusion that it has satisfactorily met the requirements as originally outlined. That the outcome was successful is due both to the close co-operation of the engineering forces of the Humble Oil & Refining Co., and the Hughes Tool Co., and to the patience and persistence of the operating department of the refinery and their conviction that it could be accomplished.

The result has been an increased over-all capacity of expensive refinery equipment and the elimination of one of the most disagreeable and hazardous operations in the process of petroleum refining.

CHICAGO.—Photographs illustrating the strength of a weld made with Fuzon super-strength metallic arc electrode have been developed by the Chicago Steel & Wire Co. Another photograph shows a metallic arc weld made with Fuzon electrodes so ductile that it may be sharply bent over the bead without showing cracks. A picture showing three stages of the transfer of one drop of metal from the electrode to the weld in metallic arc welding has been taken in the company's research laboratory with invisible infra-red light on a film specially prepared by the Eastman Kodak Co.

SCHENECTADY, N. Y.—Air compressor governors manufactured by the General Electric Co. are described in a recent bulletin issued by that company. Its type ML and MJ governors are described as single-pole switches of the quick make-and-break type designed to give uninterrupted satisfactory service with the minimum of attention.

The company manufactures a complete line of governors for motor-driven air compressors to operate at 600 volts with various current-carrying capacities ranging from 0.1 ampere to 20 amperes, and with opening pressures varying from 40 pounds to 140 pound gage.

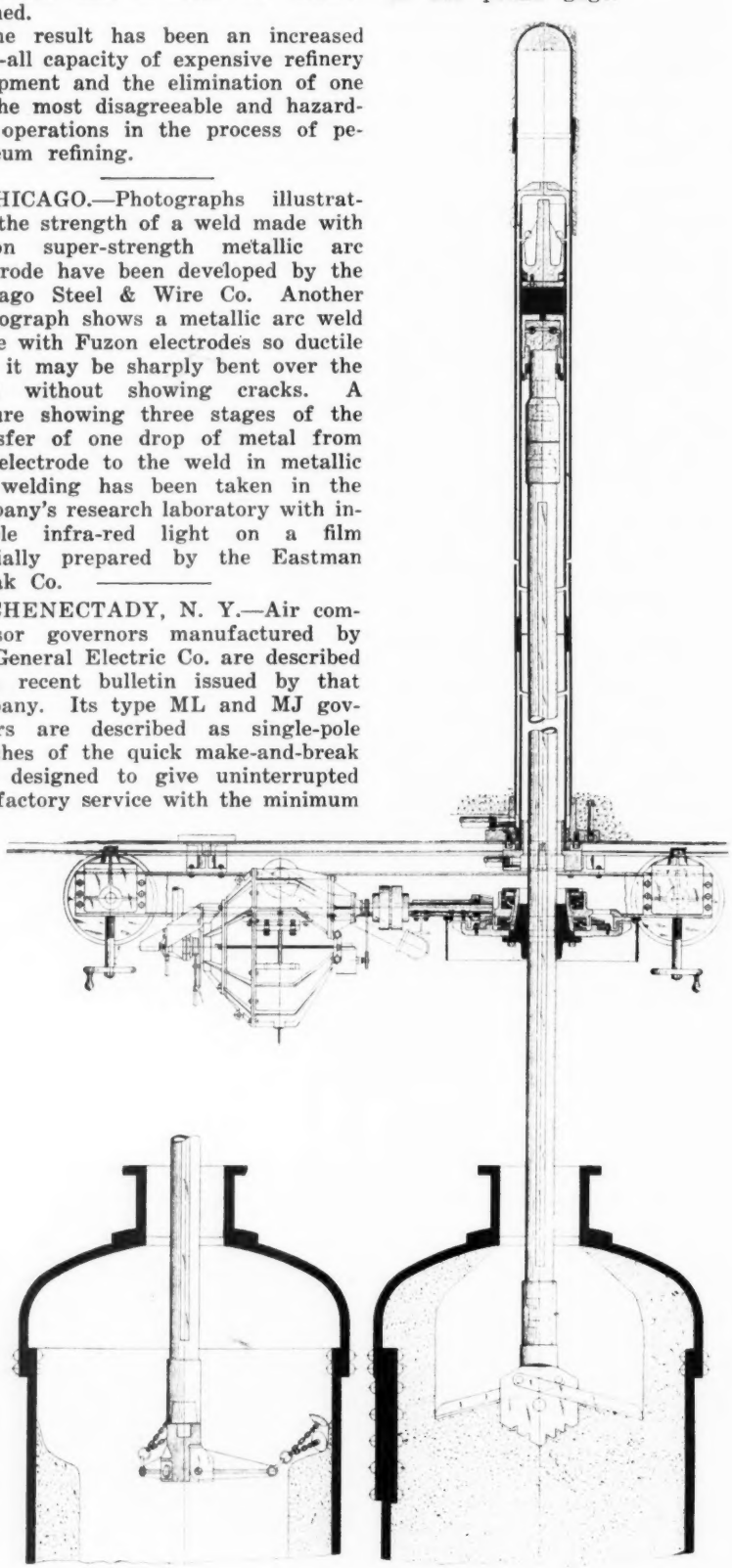

Figure 1
Layout showing how Hughes-type rotary soaking-drum cleaner for pressure still use is operated

Santa Claus drives a tank wagon,

but . . . . *not for long!*

Santa Claus is putting in some time in the oil business. To avoid being too conspicuous he has adopted the disguise of a tank wagon driver and is trying to inject the spirit of Christmas into the oil business.

His workshop is, for the time being, several new storage tanks filled with gasoline, several new tank trucks. Every morning he fills a tank truck with gasoline and departs on his round of calls on the filling station operators, spreading the spirit of Christmas.

Instead of "Merry Christmas", his greeting is, "Hello boys, two cents lower today! How many gallons"? The boys greet the old gentleman with open arms and also open tanks. "Come again, and often" they cry as he continues on his journey.

A hard, cold, unfeeling business world soon forces the fact on Santa's mind that he alone is possessed of a benevolent frame of mind; strange and insistent demands are made on him for money; the tank builder wants some, the tank truck maker says he must have some, and even the refinery and landlord add their insistent demands for money. Surely, concludes Santa, this oil business has no feeling of benevolence anywhere or for anybody. Santa makes the shocking discovery that every business, except his own magic toy shop, has what people call an "overhead" expense in addition to first costs.

Santa Claus decides that the oil business is no business for one of his benevolent spirits to be engaged in. So he turns over his tanks and trucks (to the Sheriff, we imagine) and . . . . disappears up the chimney.

The jobber who plays Santa Claus, pays and pays and pays.

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Refinery
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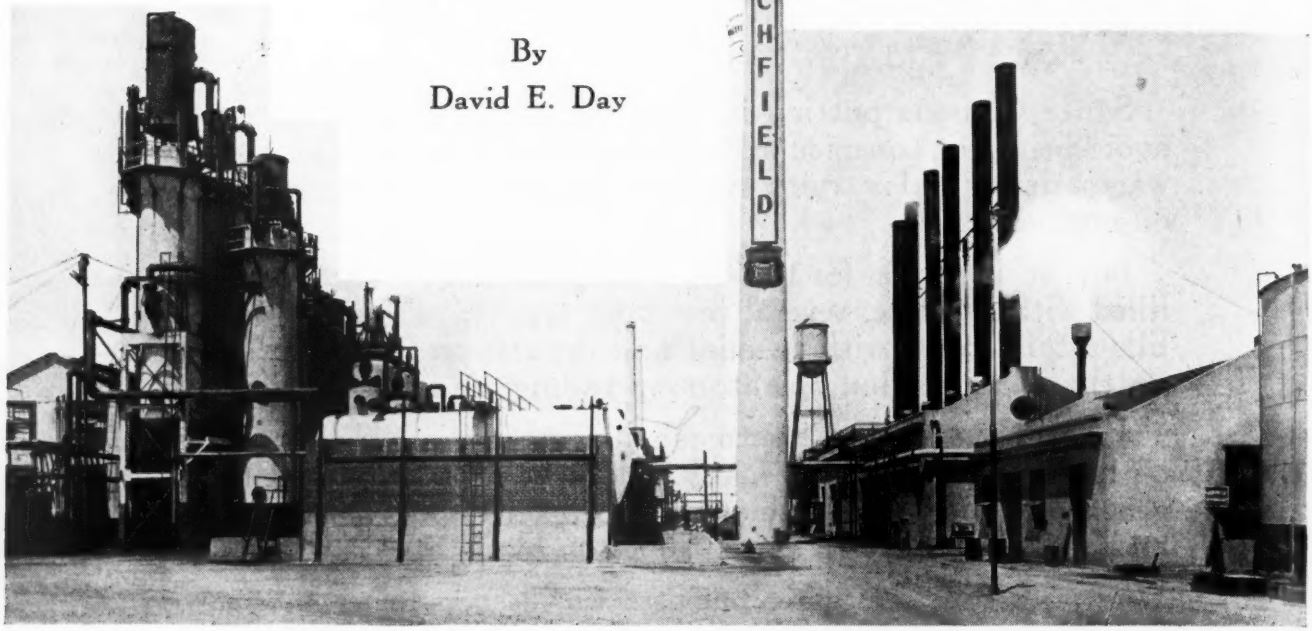
Franklin,
Penna.

The Relation of Equipment and Refinery Design, Operation to Costs

By
David E. Day



A view taken lengthwise of the Richfield refinery showing the relation of ***the boiler plant*** *(****on the right****)* ***the stills, towers and receiving*** *house*

ACCORDING to my hazy recollections of Political Economy Ia, one of the fundamental laws of economics is to the effect that the efficiency of an industry varies directly with the degree of competition within the industry. The sustaining arguments were that unregulated competition results in lower selling prices, these lower selling prices necessitate lower costs, the efficiently operated plant effects these lower costs; the inefficient plant—the "marginal producer" I believe the text books called it—cannot effect them and is forced to close its doors. All of this may be poor economics, but it is, nevertheless, good oil. The petroleum industry is now in the midst of such a period of severe competition and consequent adjustment to an efficiency basis. Throughout the land departmental shoes are becoming acquainted with executive carpets, meetings are held, appropriations knifed, and there is a great crashing of dead timber. All of this carpet walking, conferencing, knifing and timber slashing avails but little, however, unless they result in a sincere analysis of costs, the determination of the causes of inefficiency, and as complete an elimination of these causes as is practical.

Such a program cannot help but result in the general improvement of refinery technique, the development of new processes, and a constructive decrease of costs. Logically enough, this improvement ordinarily originates, not in the large company, but in the small one. In nearly every instance the larger company can buy the proportion of crude which he purchases cheaper than can his smaller competitor. He ordinarily owns, or controls, the pipelines and consequently can transport crude from the well to the refinery for less. He has well established channels of distribution and usually can get more money for his products at a lower selling cost. Naturally the impetus towards efficiency falls to the small operator. It is his only way out. To keep his head above water he must counteract these financial advantages of his large competitors by technical advances in his operations, otherwise he cannot continue to do business.

THIS general reasoning holds true for all branches of the industry, but it is particularly true of the refining department. To improve the profits from its operations, this department must do one, or both, of two things. It must either increase its returns, decrease its costs, or both. And it must do these things without the sacrifice of quality. Obviously if a refiner, by the use of more efficient methods, produces 2% more gasoline worth 10c per gallon at the expense of kerosene worth 5c per gallon from the same crude at the same manufacturing cost he has added 4.2c per barrel to the net returns of his refinery operations. If, on the other hand, his cost of refining is, let us say, 12c per barrel, and by increasing the economy and efficiency of his operations he can reduce this cost 33-1/3%, he will make a net saving of 4c or approximately the same amount as in the first instance. The obvious conclusion to be drawn from the above statement is that if a difference of 2% in yield has as great a cash value as 33-1/3% difference in costs, then refinery yields are the determining factor in profits, rather than costs. This, however, is not entirely true. Although most refineries in this country could show an increase in ultimate yield of higher priced commodities of from 1% to 5%, this cannot be done in many cases without increased cost or without a radical revision of operating methods and the installation of much new and expensive equipment. On the other hand, operating costs in many refineries could be reduced from 10% to 50% or even 60% without the expenditure of any considerable sums. For this reason, particularly in the case of smaller plants with limited capital, it is often more practical to achieve savings through the reduction of operating cost than through increase in yield. In this article the writer will first discuss refinery costs and methods of reducing them, and second refinery yields and methods of improving them.

An analysis of refinery operation develops the following major factors which are responsible for the cost of refined products.

I. Cost of raw material at the refinery
   a. Crude oil.

b. Natural gasoline (if used for blending).
c. Miscellaneous raw materials. ("Tops", partially finished stocks, etc.)

II. Cost of Refining.
a. Direct labor.
b. Direct fuel.
c. Repairs and maintenance.
1. Labor.
2. Material.
d. Chemicals and supplies.
e. Service departments.
1. Electric light and power.
2. Steam plant expense.
3. Water plant expense.
4. Fire protection expense, etc.
f. Fixed charges.
1. Depreciation.
2. Insurance.
3. Taxes.
4. Overhead, etc.

OBVIOUSLY, the refinery operator has no control over the first classification, i.e.; cost of Raw Materials. It is equally obvious that he is intimately concerned with, and has direct control over, all of the items under "Cost of Refining". Even the so-called "Fixed Charges", as applied per barrel may be reduced by increasing throughput with the same investment, depreciation, and insurance, while the other items vary directly with the efficiency and economy of operations. Carrying the analysis a step further, the individual items listed as making up refinery cost are dependent upon three factors more or less completely under the control of the manufacturing department, as follows:

a. Plant design and layout.
b. Plant equipment.
c. Plant operation.

The modifying "more or less" is used advisedly. In many instances the acting manufacturing department personnel, have fallen heir to the plant and equipment which they are operating. In these cases the department has had no control over the design of the plant, nor of its equipment, and is consequently limited to operating the existing equipment in the most efficient and economical manner possible.

The refinery with which the writer has been most intimately associated during the past several years, the Richfield Oil Company of California's main plant near Los Angeles, serves as an admirable example of how design, equipment, and operation can be coordinated to produce the ultimate results in low refining cost. The refinery was planned, laid out, and built by the personnel which has operated it even since. That this coordination was worth while is evidenced by the results. The refinery includes: a refining unit producing three grades of gasoline, two of kerosene, engine distillate, cleaners naphtha, painters distillate, stove oil, absorption oil, special cracking stock, gas oil, diesel oil and several grades of fuel finishing with a "Bunker C"; a four unit Cross cracking plant; a very complete service department including a power plant where all of the power, both electrical and steam, used in the refinery is generated, machine shop, blacksmith shop, welding shop, warehouses, water treating, pumping and circulating plant, and so forth; crude and refined products tank farm; pipe line, tank car, tank truck, drum, and retail delivery facilities for all commodities; a gasoline recovery system; waste water and sludge treating systems; and complete laboratory and office facilities. The labor, for all shifts, of the entire plant is furnished by 100 men, 47 in the Operating Department, 41 in the Maintenance Department, and 12 in the office and laboratories. As the plant is now processing 45,000 barrels of crude oil per day, this results in the rather remarkable record of 450 barrels throughput per man per day. The fuel efficiency of the plant is equally as good, as are the maintenance and repair figures.

Naturally the question of plant layout involved the consideration of other factors beside operating efficiency and economy. The transportation of raw materials into, and finished products out of, the refinery; the topography of the site; the bearing qualities of the soil; and the most economical apportionment of the property available with respect to its ultimate utility (land in this area being rather high priced) were all given careful consideration in the general arrangement of equipment. In addition to this, the insurance advisors and the Board of Fire Underwriters were called into consultation and their recommendations were followed closely, in order that the completed refinery might have the benefit of the lowest possible insurance rates. With these fundamental points once determined, the efforts of the operating and engineering divisions of the manufacturing department were directed toward the development of a layout or ground plan which would result in the greatest possible economy of operations. The features which were incorporated in this layout were as follows:

1. An uninterrupted flow of crude oil to raw, treated, and finished products.
2. Close grouping of related units with concentration of operations requiring manual control and centralization of automatic controls and instruments.
3. Acessibility of all equipment requiring regular inspection, repairs, or replacements.
4. Provision for expansion in an unilateral system.

The eastern edge of the site was reserved for auxiliaries such as the boiler plant, electric power plant, water circulating system, water cooling towers, and so forth. The east-center section consists of three units, the refinery proper on the south, the treating unit in the center, and the cracking unit on the north.

Crude oil passes through the plant in an unbroken flow from the crude

DAVID E. DAY

Mr. Day is the son of the late Dr. David T. Day, and he got his first taste of oil early in life washing bottles in the laboratories of the U. S. G. S. (later in the Bureau of Mines.) His leanings towards a career were influenced more or less by close contact with C. W. Hayes, Max Ball, C. A. Fisher, F. G. Clapp, and others.

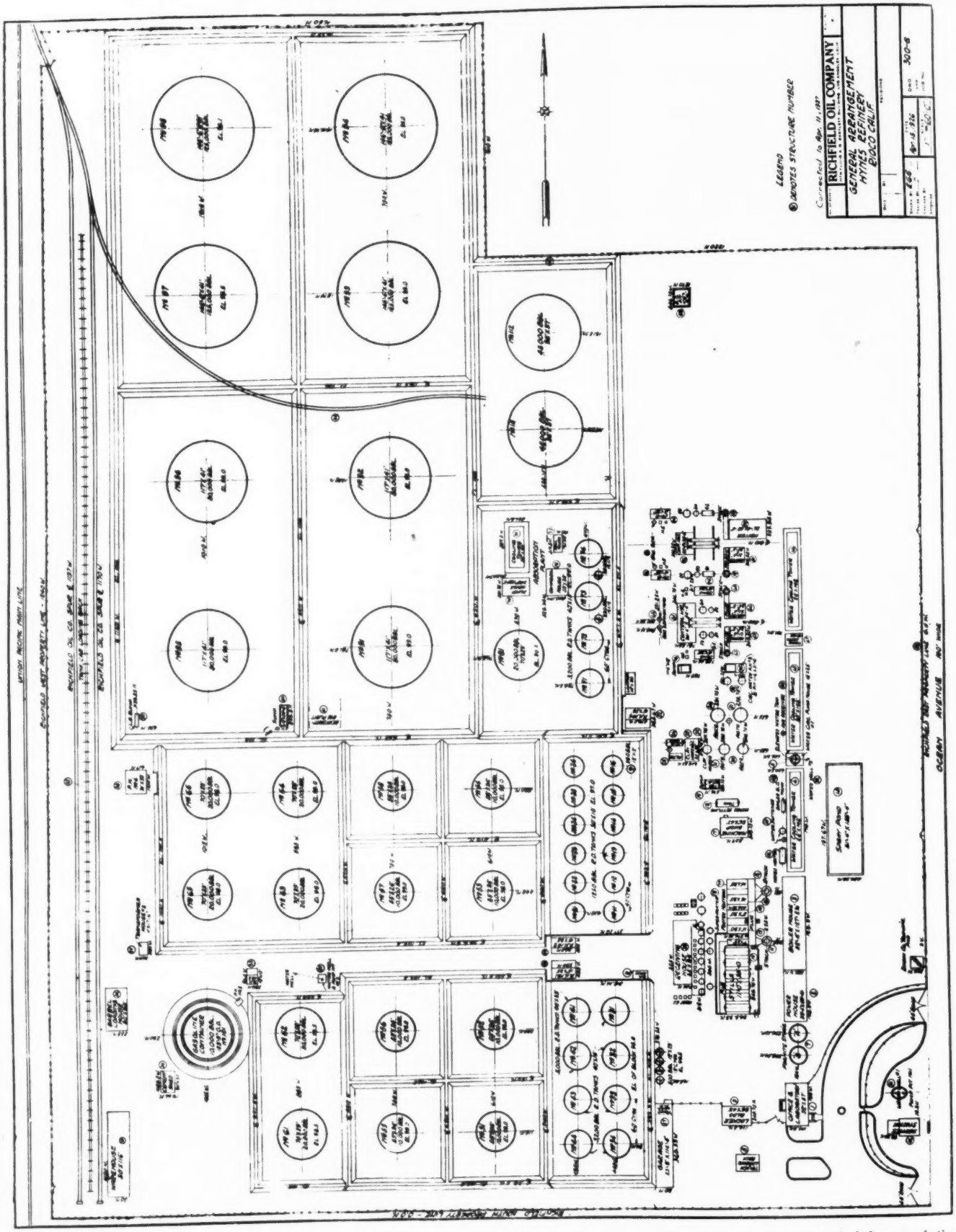
Mr. Day attended Johns Hopkins university and later the University of Wisconsin, where as Mr. Day puts it "by the grace of God and the help of the faculty I graduated in 1918," after spending six months in France as an ex-officio representative of the French High Commission investigating the supply, demand, domestic production and refining facilities of France.

Starting as a roustabout, Mr. Day worked in the producing, geological, engineering and manufacturing branches of the oil industry. He became very much interested in oil shale and made a two year study of this branch.

From 1921 to 1923 he had an office in San Francisco as a consulting petroleum engineer, specializing in refining practice, cracking and oil shale. Since 1923 Mr. Day has been refinery engineer of the Richfield Oil Co. of California.

He was assistant and associate editor of "Day's Handbook of the Petroleum Industry."

Layout of Richfield Oil Co. Refinery



General arrangement scheme of the Richfield refinery described in the accompanying article. It gives an idea of the geometrical layout of the plant and the room that has been left for orderly expansion along the same lines as those followed in the original plan

storage tanks to the refinery pump house and through the refining units. The products of distillation flow by gravity from the receiving house to the run down tanks and are then pumped to raw products storage, to the treating plant, to finished products storage, and then to the shipping department.

A great deal of care was taken in the arrangement and grouping of the various units. All of the fires, for refining plant, cracking plant, and auxiliaries are along one north and south road, the refinery and cracking plant fires being on the west side of this road and the auxiliary fires (boiler plant) on the east. No other open fires are present at any point on the property. The boiler plant, with its 2400 horsepower steam generating capacity, is housed in the same building with the 1350 kilowatt turbo-electric power plant, and both are under the same supervision. The water circulating, treating, and cooling system is located adjacent to the power plant, and being largely automatic, is cared for by the boiler house crew.

The refinery units are closely grouped in three north and south rows: a row of stills and pipe furnaces, a row of fractionating towers, and a row of condensers. The receiving house is located immediately below the condenser platform, and on the floor below this are the operating pumps for all the refinery units. All fractionating tower controls, high and low pressure steam controls, and water controls, together with recording temperature and pressure gages and flow meters for all operations are located in the receiving house adjacent to the look box controls. This reduces the total direct refining labor to two men per shift; a stillman on the receiving house floor in charge of all controls, and a helper on the ground floor who takes care of the pumps and the fires.

THE cracking plant is grouped in much the same manner, with the exception that there is a separate control house for each two units. The higher pressures and temperatures, and the greater risks involved—the cracking plant necessitate more careful supervision and control than is required in the refinery and, consequently, more labor, but the close grouping of units and centralization of controls have reduced this to a minimum.

The treating plant, being located centrally between the refinery and the cracking units can care for treating the products of both these operations under unified supervision and with a minimum amount of labor. As will be described subsequently, under equipment, the treating plant uses continuous processes wherever possible and labor and chemicals are much reduced by this means.

The third point, that of accessibility of equipment, is so obvious that its importance is often neglected. It is astonishing what savings can be made in man hours if condensers and heat exchangers are arranged for easy, rapid cleaning and are manifolded so that one unit may be shut down for cleaning and repairs without disturbing other units. The same is true of the arrangement and construction of tube stills, the tubes of which should be readily accessible for repairs and replacements. Motors should be placed with an eye to easy lubrication, pumps for quick and simple packing, tanks for speedy and accurate gaging, and so on.

This article is the first of a series of three being written by Mr. Day exclusively for NATIONAL PETROLEUM NEWS. The accompanying article discusses the relation of refinery design, equipment and operation to costs; the second article will discuss equipment and refinery operation; and yields will be the subject of the final article.

Provision for expansion, our fourth point, can affect refinery costs in two ways. In the first place, if adequate provision is not made, expansion will often necessitate shut down of the operating equipment, loss of production, and greatly increased construction costs all of which must be charged against the new units and will ultimately appear as increased overhead. In the second place, unless ultimate expansion has been carefully provided for, it may be impossible to place the new units in their proper relation with the old. This may often result in the necessity for an entirely separate operating crew for the new equipment whereas, if proper provision had been made, the crew operating the old unit could handle the new as well. The plant was built to run 10,000 barrels of crude oil per day and started operations in July, 1924. It is now running 45,000 barrels of crude per day, and the cracking plant has been added also. So thoroughly had expansion been planned for that every unit lined up exactly with the old ones, new construction progressed without interruption of operation and without increased construction costs, and new units were "cut in" with operating shut down of only a few hours.

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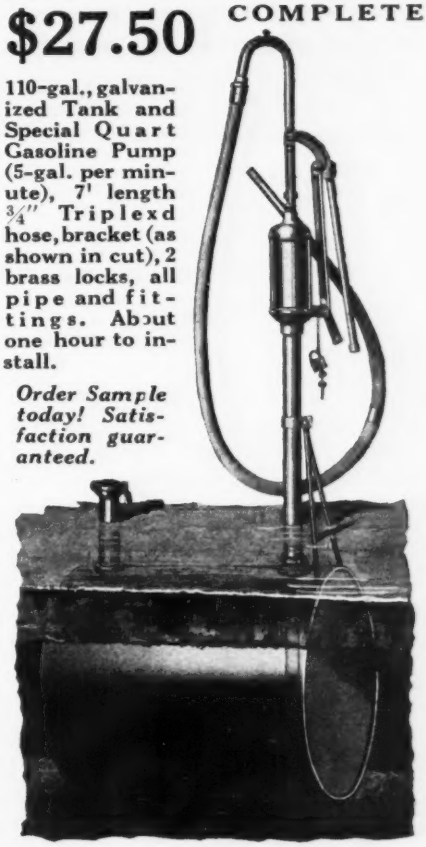

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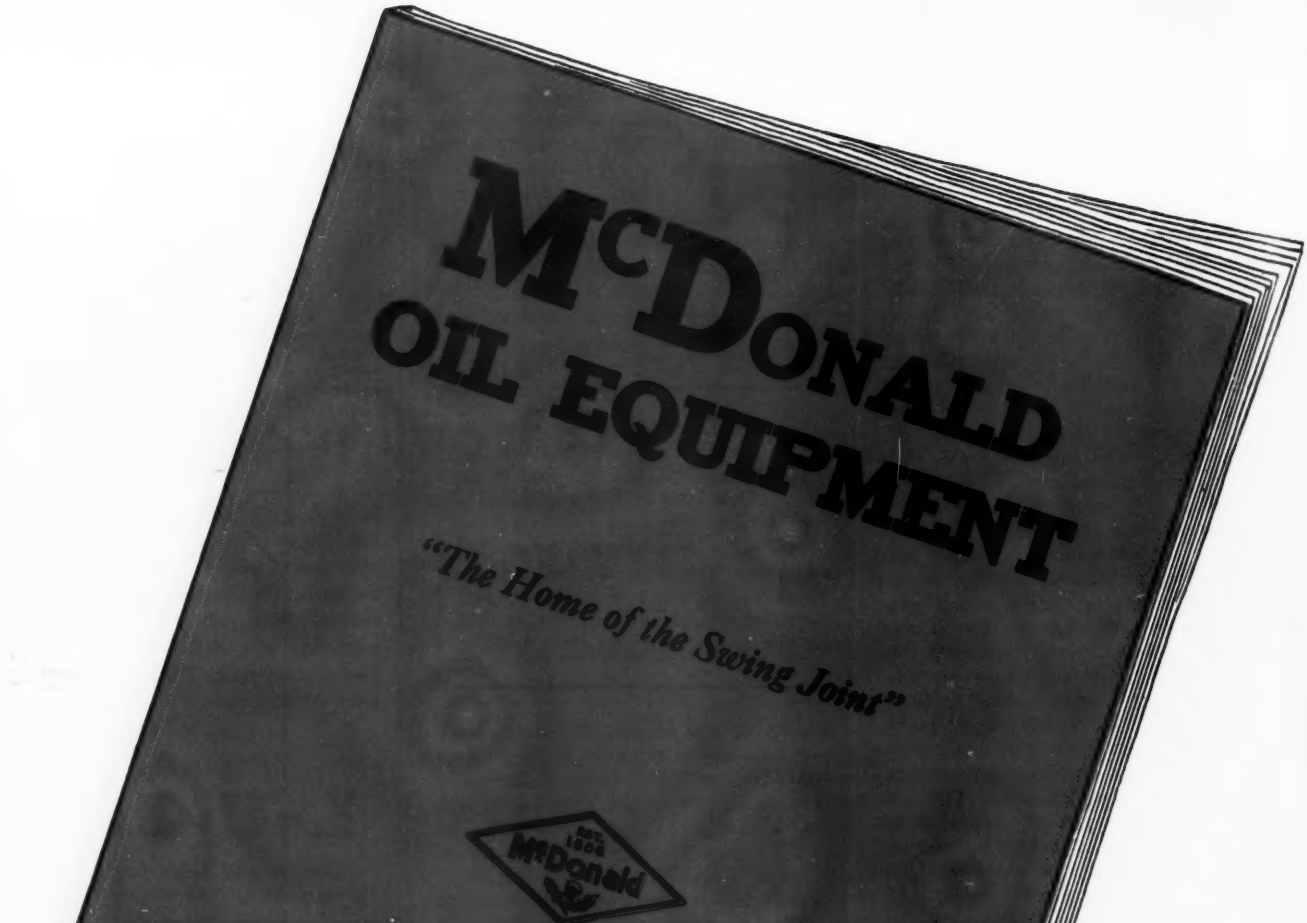

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Remodeling a Shell Still Battery; Factors to be Considered

By W. E. Perdew*

IN GENERAL, oil distillation equipment is remodeled to increase charging capacity; to improve fractionation and stripping, with the elimination of all rerunning, and obtain maximum yields of the most valuable products; to provide for special cuts; to lower fuel consumption; and to make the operation of the equipment independent of atmospheric conditions.

The first question that arises is—should the shell still battery be remodeled, or should it be scrapped and more efficient apparatus consisting of a tube still, or stills, or return tubular shell stills and accompanying towers be erected? The correct answer to this depends upon a number of considerations chief among which are:

Conditions of present equipment.

Present and probable future quality and quantity of crude oil supply.

Amount of money available for capital investment.

Fuel costs.

If the existing shell stills are small, set low with the bottoms, the settings and the insulation in bad shape, very little money should be spent on connecting new towers to them.

Figure 1 shows a battery of six relatively small stills. The crude

W. E. PERDEW

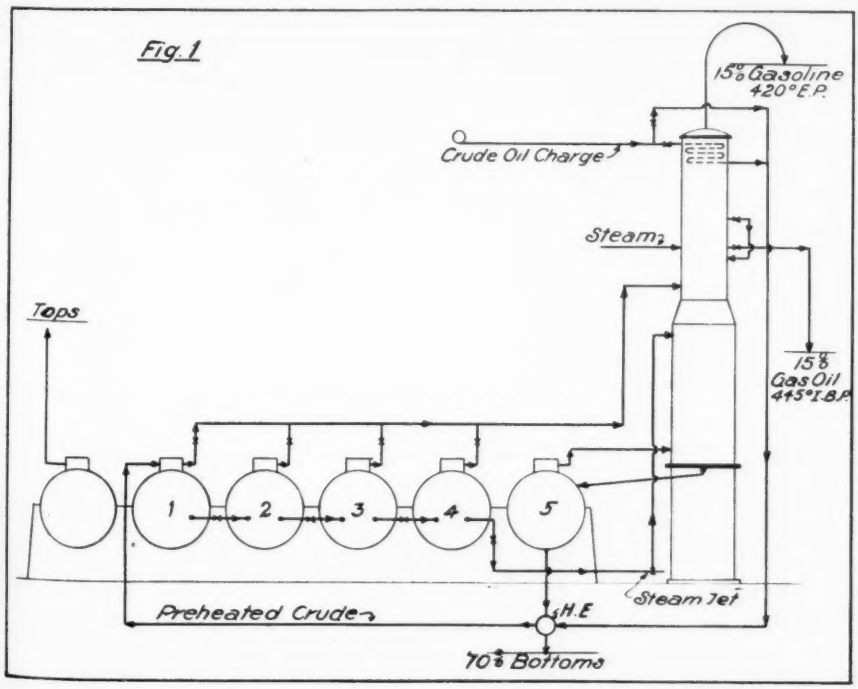
supply is confined to grades of heavy crudes which do not yield a good kerosene. One grade of gasoline is desired. There is cheap gas fuel that will apparently last for years.

Five of the stills in the new hookup will give the desired capacity, leaving one for rerunning. The tower is large enough and so located that it could be used in connection with a tube still furnace which might replace the shell stills at some future time.

Relatively high capacity is a feature of this type of hookup.

Each refinery presents problems peculiar to it alone and only generalizations will be attempted in this discussion. Possible patents are not considered or discussed.

*Winkler-Koch Engineering Co.



THE ordinary existing continuous shell still battery can never be made as efficient, as regards fuel consumption, as tube stills or return tubular shell stills, when taking off the same percentage overhead; and fuel consumption is frequently largest item of operating costs.

The continuous shell still battery, however, does possess certain advantages. It is or can be made more flexible than a tube still hook-up, being capable of yielding a larger number of closer cuts with relatively low capital expenditure and a simple flow sheet. Operating labor, and repair and maintenance costs of control devices and pumps are about the same with both types of equipment.

The tube still of good design requires slightly less maintenance expenditures. Where a shell battery is in generally good condition, well laid out and connected to good condensers and tail house and when fuel is relatively cheap, it will take several years for the net difference in total operating and maintenance costs to pay for erecting a tube furnace and towers, and practically scrapping the shell still battery.

In cases of this nature it is probably best, from all considerations, to fit good fractionating and stripping towers onto the shell stills. When putting towers on a shell still battery it should be kept in mind that at some future time it might be desirable to connect a tube still furnace before or after the shell battery, or entirely to replace the aged battery with one or two tube furnaces. The foundation locations, the size, the design of the tower shells, and their hook-up should be selected with this thought.

WHEN remodeling, enlarging or replacing shell still batteries, the refiner desires to provide for these features:

Low operating costs, including

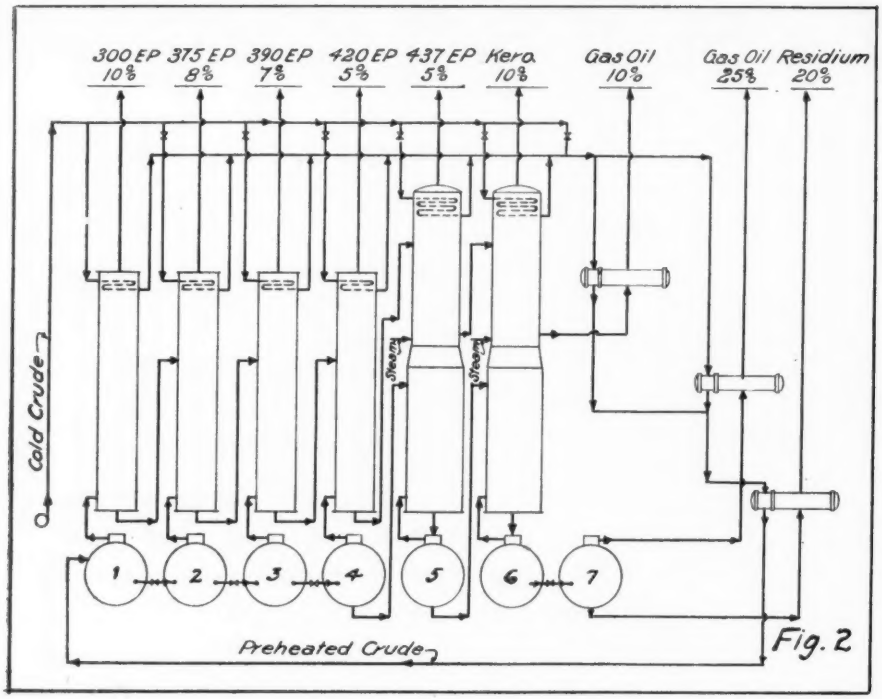


Fig. 2

labor, fuel, steam, pumping, and condensing and cooling water.

Complete separations of present and possible future most valuable commercial products, i. e., maximum yields.

EXTREME flexibility, to the end that the market can always be met and the most profitable combined yields be obtained always from a wide range of crudes.

Real operability, embodying a simplicity of controls and flow sheet so that the streams are always what is wanted, and are obtained with ordinary workmen under ordinary supervision.

Low total maintenance, repair, and clean out costs including both lost time on stream and labor and material.

Low depreciation and obsolescence.

Low capital investment.

It is axiomatic that the last item cannot be strictly effected and at the same time amply provide for those preceding it. In putting in equipment the refiner gets just about what he pays for. Substantial capital savings can be made, however, by applying judgment and study to the flow sheet, and in selecting properly designed pieces of equipment.

Most refiners have a limited amount of capital available for improvements and betterment. It is not a case of deciding upon what improvements would eventually pay out; but rather upon those of many possible improvements which will yield the quickest and largest returns.

Figure 2 represents a not uncommon example of a battery provided with inefficient towers, but otherwise in good condition. Knock-back coils are put in the tops of the existing towers on the first four stills. If these towers are such that the end-points can be controlled by the knock-back thus provided, they are not otherwise altered. If they are no better than just plain cylinders, as regards fractionation, a few bubble decks are put in them,—just enough so that the end-point may be kept within the gasoline range, with a small reflux, when the stills are being worked to capacity.

Very frequently a proper return on the investment will not result from equipping all stills with large, very efficient towers. Hence present towers are worked in where possible.

All towers are insulated and weatherproofed. This applies to all installations.

The reflux from one tower is jetted up into the next tower, where it supplies a part of the required cooling, and is itself farther fractionated, without being completely revaporized as would be the case were it returned to the still. This feature increases the capacity of the battery, as does the heat exchange with the knock-back coils and heat-exchangers. By keeping this reflux up in the towers, a very substantial gas oil cut is taken off the last tower. This cut is fairly closely cut, or can be made so. However, the color may not be so good, because of a little direct entrainment from any of the stills. If it is essential that the first gas oil stream have a good light color, the entrainment can be eliminated at relatively small expense and operating effort.

By putting a small amount of stripping steam in Towers 5 and 6, No. 5 stream can be substantially gapped from No. 6 and No. 6, the kerosene, from the gas oil cut off the side of No. 6 Tower. Steam jets are also used for jetting the bottoms of Stills Nos. 4 and 5 up into the succeeding towers.

The distillation curves of the overhead products can be varied at will between rather wide limits.

EXISTING equipment, as for example tower shells in which bubble decks may be placed, should be used wherever it is possible to do so to advantage. However, the utilization of poor and unadaptable existing equipment easily can be made

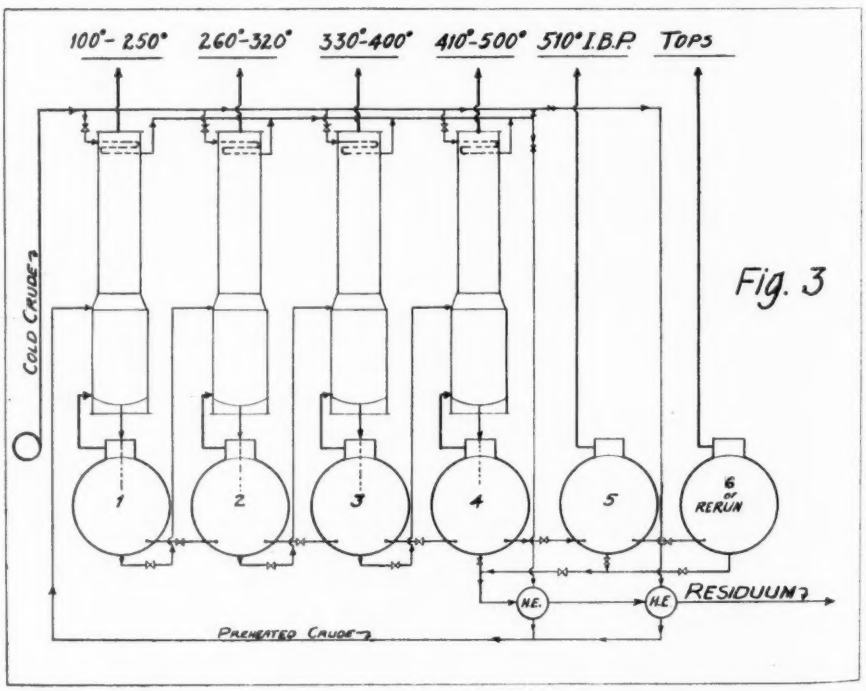


Fig. 3

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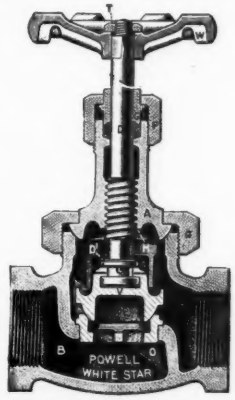

Fig. 102 Bronze White Star Globe Valve
Sizes ¼ to 3 inch
200 pounds, Extra Heavy for 300 pounds W. S. P.

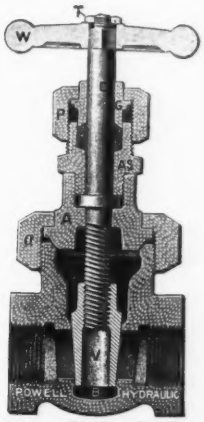

Fig. 178 Bronze Hydraulic Gate Valve
Sizes ½ to 3 inch
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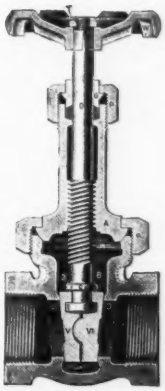

Fig. 375 Bronze White Star Gate Valve
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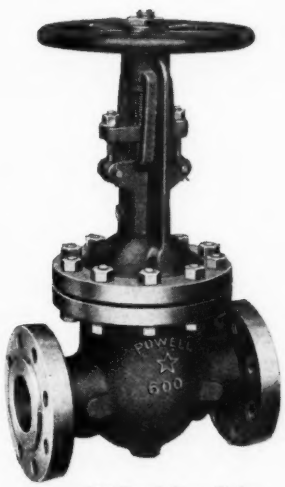

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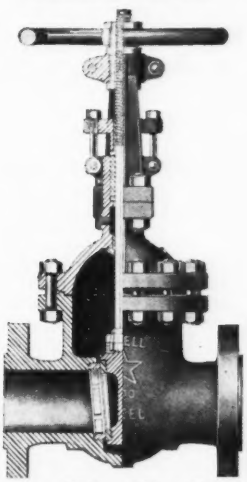

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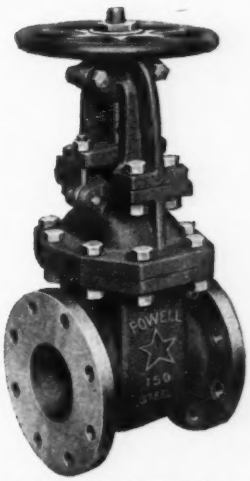

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a very expensive economy, whereby the whole investment in remodeling is jeopardized and an inefficient, unoperable job results.

Fuel is generally the largest item of direct operating costs. When there is a reasonably assured supply of cheap natural gas, coal, or heavy refinery residues of such character that they can have but little open market value, there is not the incentive for putting in equipment to save fuel and steam.

When fuel is or will probably become high in unit cost, the typical shell battery should be replaced with a tube still or stills. Or at least all feasible vapor and bottoms heat exchange should be provided for; and insulation, still settings, draft, burners, etc., worked over.

If fuel cost is low, the most expensive, least effective, and most troublesome of these items may be left out to advantage. In general, however, it pays real profits to spend money on heat exchangers, insulating, piping, etc., and on supervision to save heat, no matter how cheap fuel is. The saving is not only in the fuel, but also in wear and tear on equipment, involving replacement material and labor, in increased capacity, and in treated boiler feed water and cold condensing and cooling water.

Usually there is more heat in vapors than there is in bottoms, although the temperature gradient is not as high.

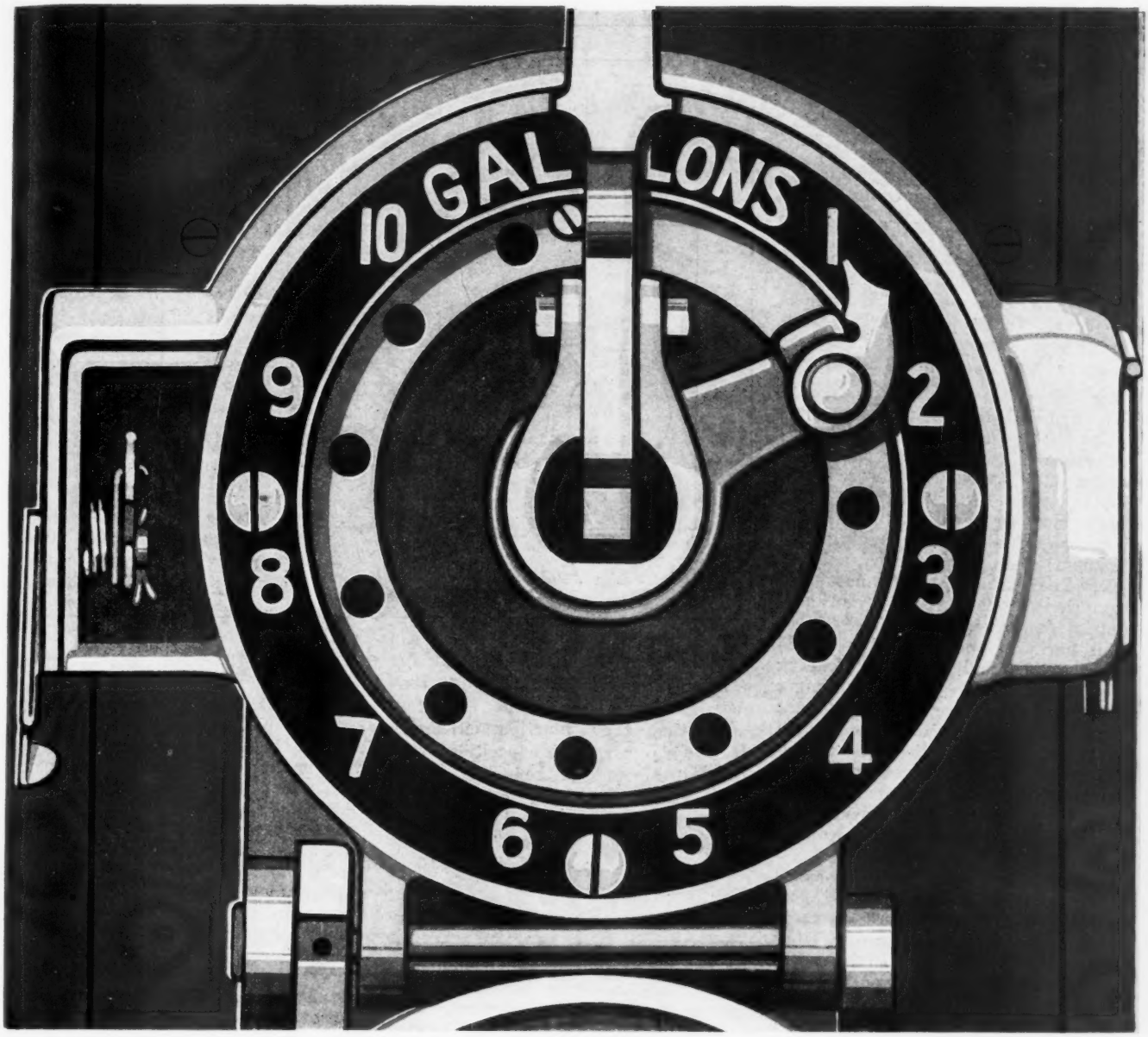
When the percentage of bottoms is small, and they have a tendency to plug exchange equipment, it is frequently best to omit bottoms heat exchange equipment, even if they are very hot. By exchanging heat in the vapors, condensing water consumption is lowered.

In this connection the closed knock-back coil in the tops of towers, through which a controlled part of the cool charge is fed, is desirable, because it produces the right kind of absolutely clean reflux in the top of the tower, and at the same time effects vapor heat exchange and takes a large load off the condenser.

Figure 3 represents a hook-up for making special naphthas or other close cuts. By jetting the bottoms from one still up into the succeeding tower; and by returning the reflux from the towers to the stills, each stream can be made very close cut, and substantial gaps can be obtained between the streams.

If the stills in the battery are small, and there are more of them, two or more stills can be connected to one tower, which is a large efficient bubble tower.

This is a very flexible arrangement. The distillation curves of the streams can be varied between rather wide limits, and the streams



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can be gapped or over-lapped at will. By providing steam jets for transferring the reflux from one tower to the next, high capacities and low fuel consumption can be attained when it is desired not to gap the streams but to operate for one or two grades of gasoline, a kerosene of relatively low flash; and a gas oil gapped from the kerosene.

Vapor heat exchangers are not shown, but may be used, especially on the last two streams, if fuel is expensive. The same remarks as regards heat exchangers applies also to other types of installations.

IN SELECTING heat exchangers for both vapors and bottoms, preference should be given to the counter flow, turbulent flow, multitubular type. In general, the tubes should not be smaller than 1-inch diameter to eliminate plugging and attendant cleaning, as much as possible. The tubes should not sag. Expansion should properly and adequately be taken care of.

All parts of the exchanger should be accessible, and thorough cleaning should be easy. High chromium steel, or other corrosion resistant alloys should be used, especially in the tubes, whenever there is a possibility of much corrosion. Exchangers should be insulated, mounted so they can easily be opened and cleaned, and piped up so they can be by-passed.

Considerable heat can be saved in the selection of hook up and flow sheet.

Direct and indirect operating labor is almost directly proportional to the "operability" and layout of the plant.

It is not very feasible to run a battery with one man per shift, part of whose attention must be given to other duties. Where the installation is compact, and the controls centralized and chiefly automatic, one man alone per shift can handle a battery of good size when liquid or gas fuel is used.

Wasteful and unnecessary use of steam in the stills should be eliminated by providing for positive transfer from one still to another, and by providing clean crude. The former can generally be handled by a steam lift, using less than 1½-pounds of steam per barrel of oil transferred; crude can generally be cleaned by preheating with heat exchange and settling in tanks from which the vapors are saved; or by preheating, washing, and settling. Hot oil pumps can be eliminated to a large extent by using steam jets for transferring, the latter requiring no more steam and certainly less attention.

The fractionating towers should be such that they will operate efficiently and to capacity with considerable dirt accumulation, and for a long period without cleaning; that cleaning is easy when it is necessary; that they function efficiently at a wide range of capacities; that a small amount of reflux is necessary; that control is positive and easy at all times; and that they are not subject to corrosion. The bubble tower best meets all these conditions.

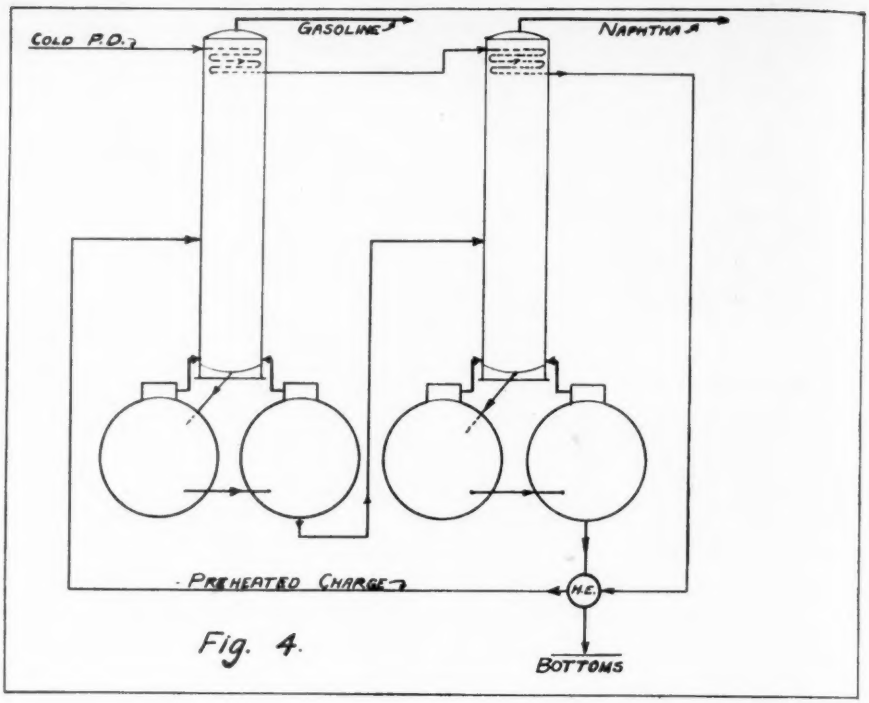

Fig. 4.

TOWERS should be large enough in diameter and efficient enough, and the hookup should preferably be such that each stream, and certainly each commercial product, can be gapped at will one from the next; i. e., the initial of the succeeding stream being substantially higher than the end-point of the preceding stream by standard distillation. This gives a flexibility that will enable the refiner to run different crudes and to meet most profitably the not infrequent sudden and wide changes in price structure of refinery products. It is understood, of course, that the products are not actually gapped, when efficient test distillation methods are employed rather than the standard test methods; also that competition often requires the furnishing of a kerosene and a household heating distillate containing a considerable amount of material distilling below 437° Fahr.

It should also be realized that it costs money (fuel, steam, and lowered capacity) to produce gaps, and they should be sought only when advantageous because of specifications of products, and the market structure, together with percentage yields.

Good fractionation and stripping will always give higher yields of products that have lower end-points. For example, a good tower will produce a higher percentage of gasoline having 400° Fahr. end point, than will a poor tower of 437° Fahr. end point gasoline.

There are many refinery executives and superintendents who sincerely but erroneously feel they are getting maximum yields of the most profitable products, and that any change in the distillation curves of the products being made would render the latter of poorer quality. Even in this enlightened day, with its many improvements in refinery equipment and operation; and with net refining profits possible only with low operating costs and highest possible recovery of the most valuable products, there are many refineries in which gasoline and kerosene yields can be increased by as much as 5 per cent, with a good hookup and good fractionating and stripping equipment.

It is just about as important to get all the good kerosene, as it is to get all of the gasoline, and good fractionation is just as essential for quality and yields of kerosene as for gasoline. There are many refineries where the end point of kerosene can be reduced by as much as 50°, the yield increased several per cent at the same time, and a product produced of superlative color and burning qualities.

Figure 4 represents two rather large bubble towers, each connected in series to two relatively small shell stills. These are for running treated pressure distillates. With the flow sheet shown in Fig. 4, 400° F. P. gasoline is taken off No. 1 tower,

a naphtha with 415° F. initial and 460°F. end point, is taken off the second tower, and the butts from No. 4 still have an initial of 480°. All of the charge goes in series through the knock back coils, furnishing practically automatic control. The cuts are controlled by the temperatures, and the amount of steam injection, in the bottoms of the stills. Steam is not necessary to produce the required fractionation and stripping, but bottom steam is necessary for color and color stability of the overhead, if the P. D. has a critical temperature.

The controls may be such that end-point gasoline is taken off the first tower and naphtha of gasoline end-point off the second. This naphtha may be made for special purposes, or used for absorbing gasoline from still and cracking plant gases.

With suitable connections the towers may be run in parallel, each taking all gasoline of any required end-point out of the charging stock.

If the stills are large enough, one still to the tower is sufficient.

The four small stills shown in Fig. 4 can be replaced by two return tubular or water tube boiler type of stills, if fuel costs should become an item.

Above all things, the revamped battery must be thoroughly operable. The streams always must be finished as regards distillation. The desired products must be of constant desired quality. Irrespective of theoretical efficiency or first cost, no equipment should be put in that is not thoroughly operable by the ordinary refinery personnel. The safe working capacities of the various units should be ample to handle unexpected and unusual overloads.

Selection of the proper valves and fittings; the use of cast iron and other corrosion resisting alloys in apparatus where corrosion is most likely to occur; and adequate provision for expansion, contraction, freezing, and draining will go far towards reducing depreciation, maintenance costs, and time off for repairs and replacements.

Obsolescence is reduced by incorporating in the improvements the latest and best proven ideas and practices.

While the correct kind of remodeling will eliminate all products that will require rerunning, nevertheless some products will accumulate which will require redistillation. Trap stops must be taken care of. The contents of a rundown or of a finished storage tank may be accidentally contaminated and require redistillation. If the size of the units of the new distillation equipment is adequate, this can usually be taken care of best by adding the off quality material to the crude, or by feeding it into the proper tower.

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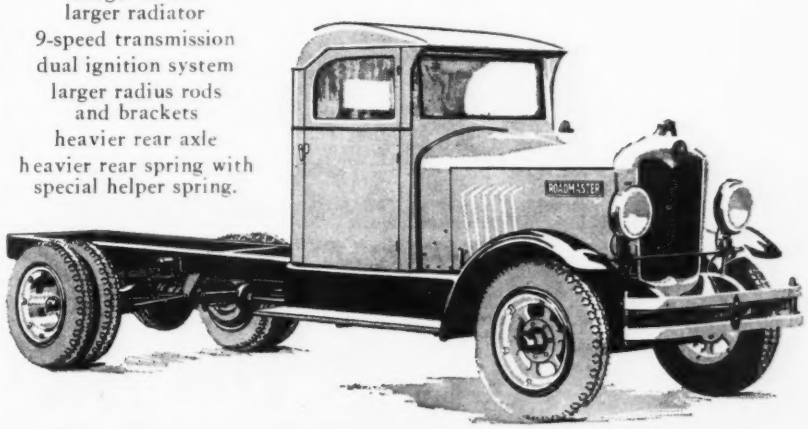

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Temperature and Pressure Instruments In the Petroleum Refinery

By W. C. Begeebing

THIS article discusses from one standpoint—an important one—a number of the most vital processes in the petroleum refining and natural gasoline industries. For each of these processes there is one best temperature—a range of just a few degrees—above and below which the cost of processing runs higher and the properties of the product differ from the requirements.

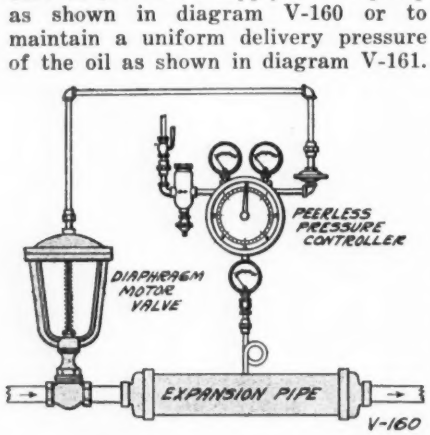
Pressure, too, plays an important part in many processes. Liquid level must be regulated in others. In order to assure this one best condition, reliable instruments are required. The variety of equipment used in plants has led to the design and manufacture of many and diverse types, sizes and arrangements of temperature and pressure instruments—indicating instruments, recording instruments and devices for automatic control.

This article is free from theory and contains practical information systematically gathered. No information of a confidential nature, concerning processes or applications, has been included.

Pumping Stations

ON THE oil outlet from each pumping station, the use of a recording pressure gage is an essential requirement.

If steam pumps are used, a pressure controller should be provided, either to maintain a uniform pressure of the steam supply to the pump as shown in diagram V-160 or to maintain a uniform delivery pressure of the oil as shown in diagram V-161.



For electric pumps, a uniform delivery pressure of the oil is obtained by an electric-contact pressure controller arranged as shown by diagram V-162.

On Diesel engines or gas engines, maximum efficiency can best be achieved by the use of the following instruments:

First, the circulation of the cooling water in the cylinder jackets can be automatically regulated by a reverse-acting self-operating temperature controller arranged as illustrated in V-163. From this diagram it will be noted that the controller valve is placed in the water outlet and will operate so that when the temperature becomes too high the valve will open, increasing the water circulation. When the temperature falls the circulation is checked by the closing of the controller. However, in order to assure always a small circulation past the bulb, a small by-pass around the controller valve is provided.

Second, the temperature of the exhaust gases should be considered, for this affords the simplest guide to the efficiency of any internal combustion engine. These engines are heat engines and consequently too high an exhaust temperature indicates low efficiency. With a mercury-actuated dial-indicating thermometer on the exhaust pipe from each cylinder, a comparison of the efficiency of each cylinder is available.

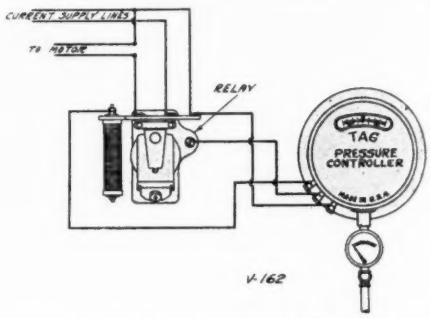
The third application concerns the failure of the lubricating oil feed to the bearings and other causes which result in overheating of the bearings. A mercury-actuated dial-indicating thermometer with its bulb suitably located in the bearing block will give advance notice of this condition before the bearing has reached a temperature high enough to result in its injury.

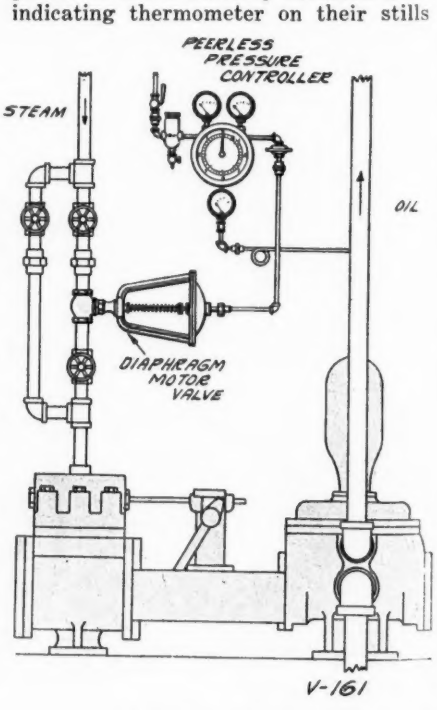
W. C. BEGEEBING

Mr. Begeebing was born in New York city in 1899. *He was graduated from New York university, from the mechanical engineering course, in* 1919. *After being engaged in engineering work with Terry & Tench and the Hyatt Roller Bearing Co., Mr. Begeebing for the past six years has been with the C. J. Tagliabue Mfg. Co., Brooklyn, manufacturers of oil testing instruments. His present position is sales manager of the recorder-controller division.*

Stills

ON ALL stills recording thermometers are invariably used as a guide to the stillman and for the permanent records thus obtained. The mercury-actuated recording thermometer has established a wide reputation for accuracy and durability on this severe service. A few oil companies prefer to use a mercury-actuated dial-indicating thermometer on their stills

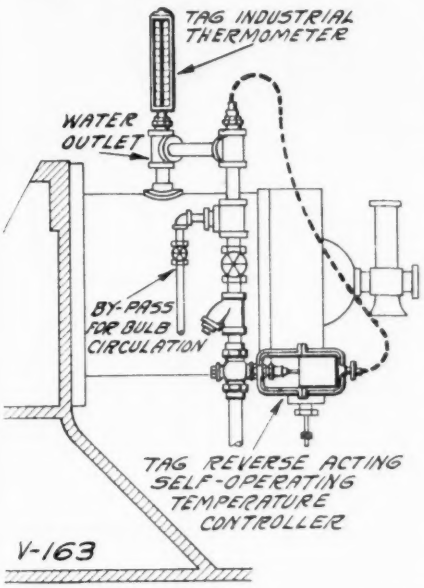




rather than a recorder because a dial thermometer can be read at a greater distance than can a recorder.

Pressure stills also require a recording pressure gage and vacuum stills should be equipped with a recording vacuum gage together with a mercurial vacuum gage or an absolute pressure mercury gage. Industrial thermometers on the still are durable and accurate and offer an inexpensive means of checking the accuracy of the recording thermometers.

For gas-fired stills, an air-operated temperature controller should be installed, as shown in diagram V-164. It will be noted that a tandem diaphragm-motor valve is used. This type of valve has openings for both the gas and the atomizing air. If the burner is of the atmosphere type only a single diaphragm valve is necessary to regulate the gas flow. In

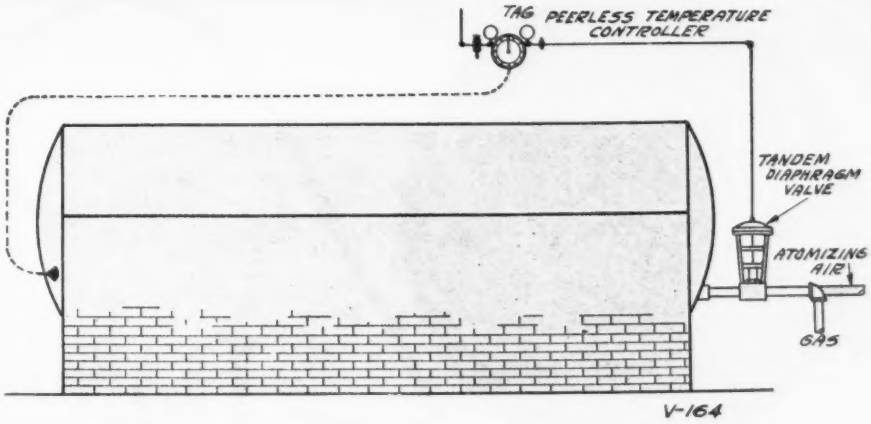


any event a by-pass must be provided or the valve adjusted to prevent tight closing so that even with the valve in the closed position, enough gas will be supplied to the burner to maintain a pilot light.

Crude Oil Storage Tanks

MANY oils, especially those stored in tanks above ground, must be heated before they can successfully be pumped. In some cases, it is required that they be maintained at proper pumping temperature at all times. Heating is accomplished by means of closed steam coils in the bottom of the tank, which may be regulated by an air-operated temperature controller. However, as compressed air is often not available on tank farms, and as great accuracy of control is not required, it may often be necessary to use a self-operating or steam-operated temperature controller. Where automatic control is not applied, a recording or an indicating thermometer should be used.

The use of an automatic shut-off valve is also recommended and this



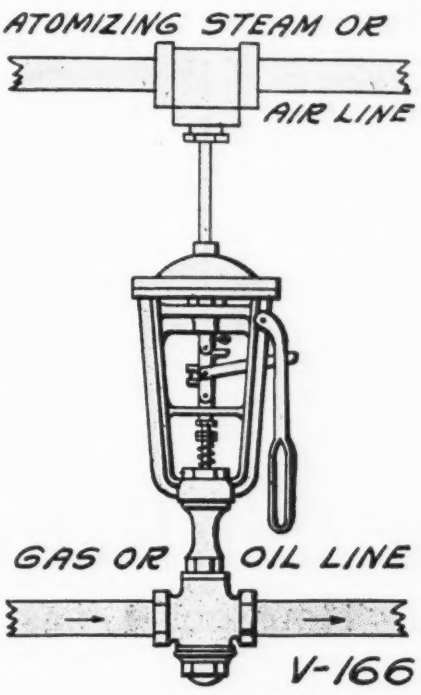
safety device should be installed. If the gas pressure drops below the setting point of the valve, it shuts and remains shut until reopened by hand. A momentary interruption of the gas flow would extinguish the burners. When this occurs, the shut-off valve closes and does not reopen when the gas flow is resumed, thus preventing a dangerous accumulation of gas in the combustion space.

For oil-fired stills the installation of the shut-off valve is somewhat different. Sometimes it is desired to shut off the oil whenever the atomizing medium (steam or air) falls below a minimum point, in which case the arrangement is as shown in diagram V-166.

It is also possible to shut off the oil whenever the oil itself drops below a certain pressure—a seal at the top of the diaphragm chamber being necessary, however.

Cracking Stills

ALL cracking systems consist essentially of (1) a shell or pipe still in which the oil is subjected to sufficiently high temperature and



pressure to crack it; (2) a soaking drum, expansion chamber or reaction chamber in which the oil passes from the liquid to the vapor state and in which the coke and heavy residue formed by the cracking operation collect; (3) a dephlegmator or fractionating tower through which the vapors pass and are partially cooled, thus affording a means of regulating the end point of the final products; (4) a condenser for the overhead from the dephlegmator and to cool the tower bottoms for recharging stock storage; (5) a pressure release valve to maintain a uniform back pressure on the entire system by discharging the uncondensable gases to a collecting main from which they can be sent to the burners or to a gasoline recovery plant; (6) charging stock storage; (7) gasoline storage; (8) recharging stock storage; (9) residuum cooler and run down tanks.

THE diagram of a cracking system on next page has deliberately been drawn so that it cannot be identified with any existing process. However, it shows just where and how automatic controllers and recording thermometers have actually been used with success on many of the well-known cracking systems.

A—The value of recording thermometers on the pipe still to provide charts of the oil inlet and oil outlet temperatures is so apparent that it hardly requires comment. These records indicate the furnace efficiency and the condition of the tubes. A record of the pressure is also necessary and is supplied by the recording pressure gage.

B—Another useful record is that of the pressure in the line between the reaction chamber and the dephlegmating tower and a recording pressure gage has been indicated at this point.

C—The most vital point of control is at the vapor line leaving the tower, and here an air-operated mercury or vapor-tension temperature controller should be used with a recording thermometer to provide a permanent temperature record of the exit vapors. Both bulbs should be placed in the

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vapor line close to where it leaves the tower.

The controller automatically regulates the final cooling action of the tower, either by admitting more or less water through a water coil, or by varying the volume of oil passing through an oil coil, or by varying the amount of recycled stock or fresh charging stock sprayed into the tower. Tower control is now in general use on cracking systems, not only because it assures a uniform product but also because it serves to establish a general balance on the entire system.

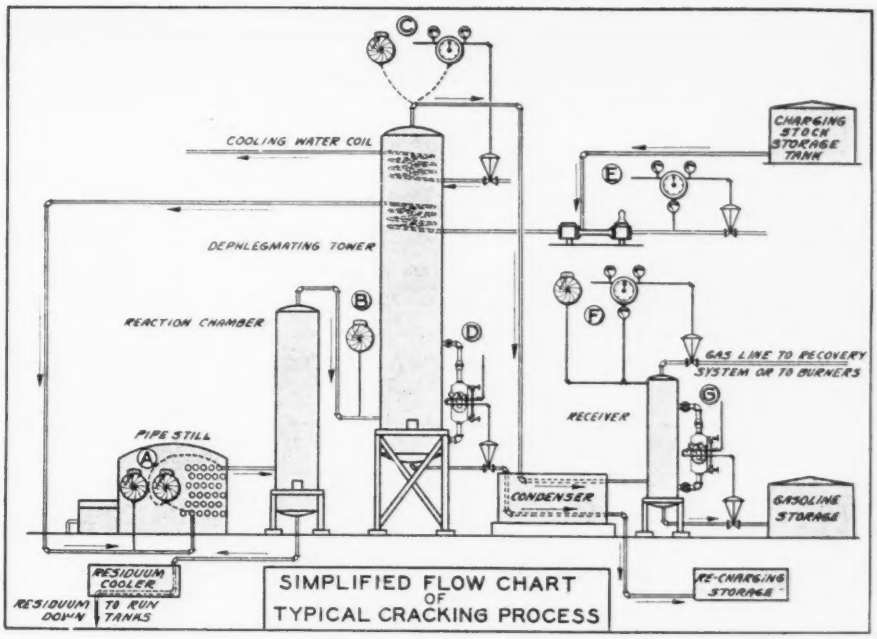
AS AN example, in one installation the control regulated the amount of charging oil circulated through a closed coil in the tower by a diaphragm valve on a by-pass across the coil inlet and the coil outlet. The charging stock thus preheated was then fed into the pipe still. Before automatic control was used the oil entering the still varied in temperature, making the outlet temperatures uneven. These variations were undesirable because they operated against uniformity in running and also subjected the pipe still and its settings to needless strain. The controller was used to automatically regulate the cooling action in the tower by means of the charging oil.

The primary object of the control—to have the vapors leave the tower at an uniform temperature—was achieved. A secondary advantage obtained was to have the oil leave the closed coil in the tower and enter the pipe still at a fairly uniform temperature.

D—For perfect uniformity of operating conditions it is desirable to maintain a constant level of the products which have been condensed in the tower. This is accomplished by the extra-heavy type automatic liquid level controller installed as shown above. The controller operates so that these tower bottoms are automatically permitted to pass to the condenser and then to storage from which they are drawn as recharging stock.

E—One of the most important factors by which uniform operation can be achieved is to maintain a uniform rate of throughput. The pump feeding the system will deliver at a uniform rate if the steam for its operation is supplied at a constant pressure. The air-operated pressure controller shown in the diagram above (detailed in V-160) has successfully replaced the usual type of pump regulators, which are not sufficiently accurate for this service.

F—Another factor which must be constant for uniformity of operation is the back pressure on the entire system. The air-operated pressure controller automatically opens the diaphragm valve on the gas release



SIMPLIFIED FLOW CHART OF TYPICAL CRACKING PROCESS

line whenever the pressure in the receiver tank is above the required point. As the gas at this point is often corrosive, both the pressure controller and the recording pressure gage recommended for this application should be furnished with protecting seals.

G—A uniform level of gasoline should be maintained in the receiver and an extra-heavy type level controller with a large factor of safety is recommended. The controller automatically opens or closes a diaphragm motor valve on the outlet line to the gasoline storage.

Condensers

THE maintenance of the right temperature of the water in the condenser box on crude, rerun or pressure stills is something usually taken for granted, and yet considerable loss may develop if this temperature becomes too high. In Technical Paper 310 of the Bureau of Mines, Mr. D. B. Dow points out that considerable gasoline passes over in the uncondensed still vapors with an excessive condenser-box temperature. Unless the refinery is equipped with suitable apparatus to recover this gasoline, it is burned under the stills or elsewhere.

If sufficient condenser capacity is present and adequate cooling water available, a greater yield of gasoline can be obtained by maintaining the condenser water at a temperature of about 85 degrees Fahr. This can only be assured by automatic regulation of the admission of the cooling water to the box. If manual regulation is depended upon the temperature will be either too low, which means a needless waste of cooling water; or, as is more usually the case, too high, causing a decreased yield of light products.

This condenser-box temperature control is especially important on the condensers of the first two or three stills of a continuous battery, the overhead from which will contain those hydrocarbons present in the crude which are lightest, and which have the highest vapor pressure.

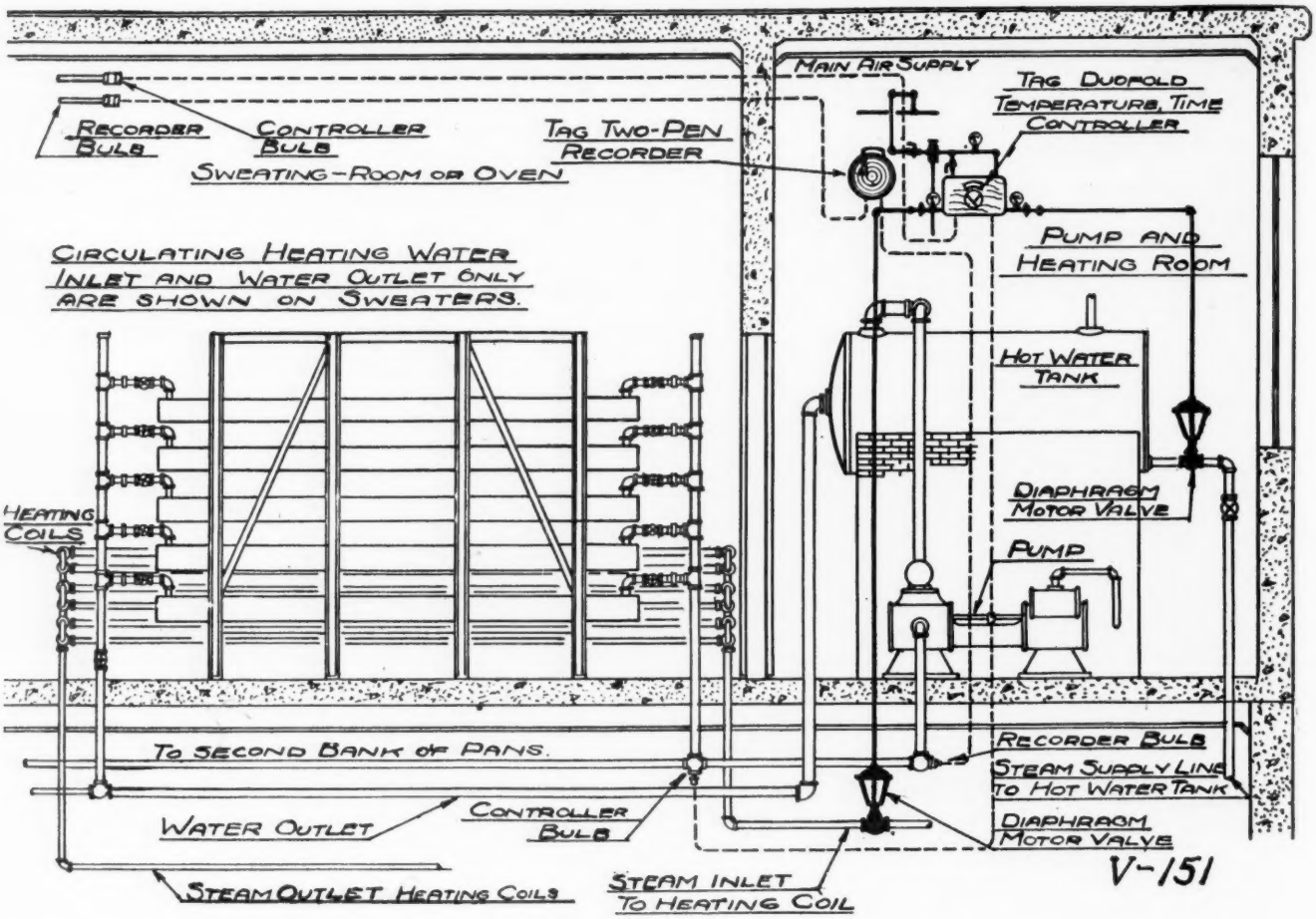
For this application a mercury-actuated air operated temperature controller is recommended.

Wax Sweaters

IN THE sweating of wax trouble had always been experienced in producing the necessary gradual rise in temperature. Even after the development of efficient types of wax-sweating chambers and improvements in the design of the pans and of the heating and radiating surfaces, the problem of securing the right temperature was a vexatious one. Hand regulation of the temperature of the hot water circulated in the wax pans and of the heating coils in the room was extremely difficult because of the large volume of the room and the long duration of the process.

Automatic temperature control has proven particularly effective for this work, and by its use many savings and advantages have been attained. Most of these advantages lead to increased production, which is always desirable. Thus, the fact that accurate automatic temperature-time-control materially reduces the time required for sweating, makes possible a larger output with attendant savings. Moreover, the accuracy of the control obtains a closer cut of the wax with the presence of less wax in the foots. This not only gives a bigger yield, but reduces re-sweating requirements.

Another noteworthy advantage is the better control of the melting point assured by automatic regulation. And finally, the reduction in steam consumption and in labor costs, repre-



sents two very important economies, resulting from the employment of temperature-time control.

Installation is usually made as shown in diagram V-151, although slight modifications are sometimes necessary. The general practice is to establish by experiment or experience, a temperature-time cycle, by which the best results are obtained. Two cams are then cut to automatically produce this cycle.

These cams are mounted on a spindle rotated by clock-work in the controller case. One cam controls the admission of steam to the hot water heater and thereby controls the temperature of the hot water circulated through the wax in the pans. The other cam controls the admission of steam to the heating coils in the room.

In most wax-sweating work it is desired to have the room temperature several degrees higher than the temperature of the water circulated through the wax. Both cams are cut so that the predetermined gradual increase in temperature is automatically produced.

But by means of adjustments provided in the controller case, it is possible to increase or decrease the water temperature or the room temperature at any time. Or, if desired, the clock revolving the cams may be stopped for any length of time and restarted, thereby arresting the increase of temperature.

Furthermore, the cams can be provided of the adjustable type. On these adjustable type cams, the duration of the rise period can be adjusted by resetting a sliding member. Thus the same controller can be used to produce a gradual rise to the desired temperature in 12 hours or 16 hours or 19 hours, or for any length of time, within the limits of the instruments, of course.

As the temperatures can be adjusted at any time, it will be seen that almost any conceivable wax sweating cycle can be achieved by these easily made adjustments. With changes in the character of the wax (or when re-sweating) the controller can be arranged in a few minutes to accommodate the altered conditions.

Indicating and recording thermometers and automatic controllers have also been successfully used on the filter presses, filtering tanks, cold settling tanks, or centrifuge systems, in compounding plants, on grease kettles, on barreling machines for wax chipping, on barrel air heaters and of course throughout the refrigeration and steam power plants which are part of every large refinery.

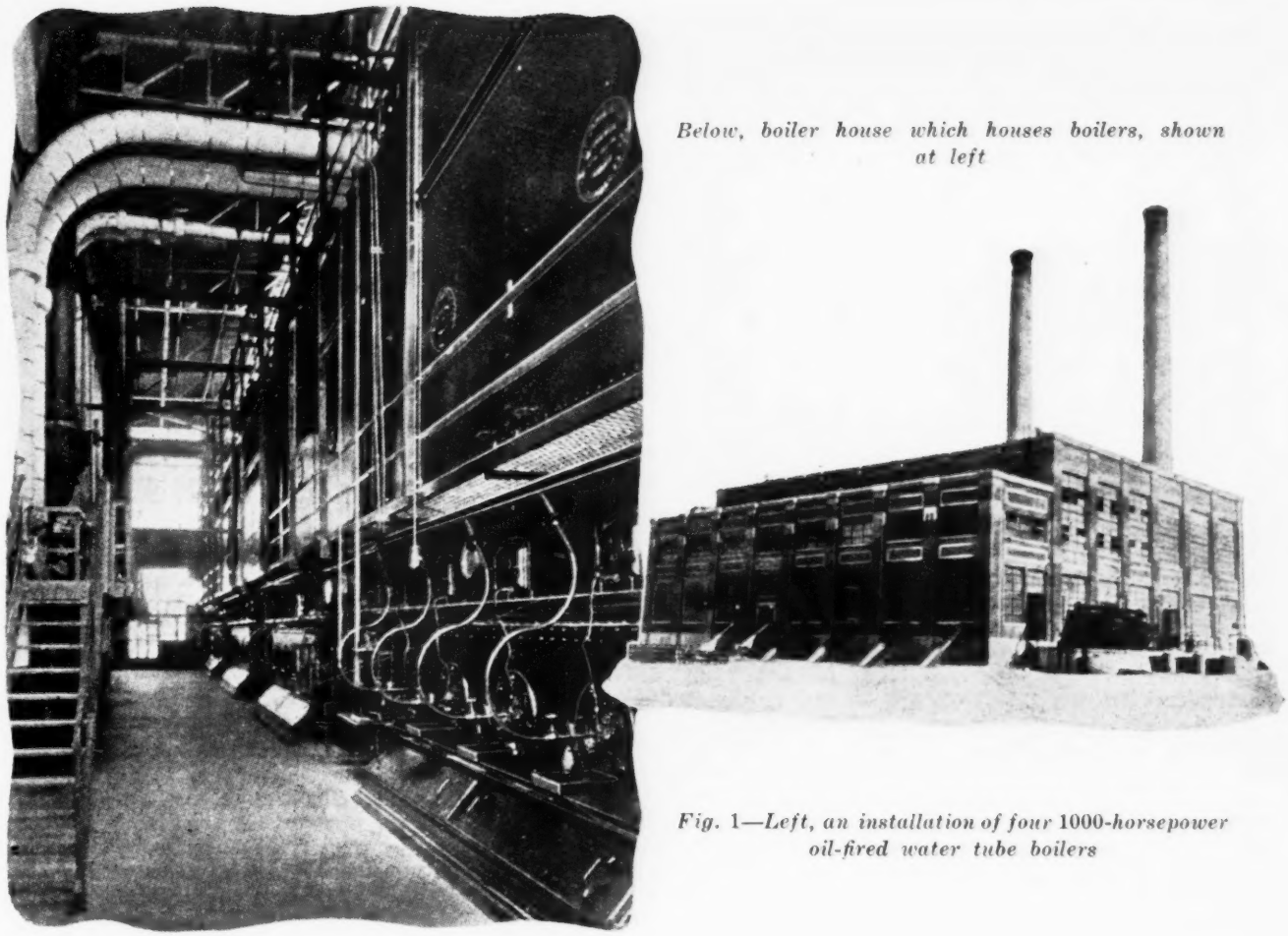
COLUMBUS, O., Sept. 17.—A special aviation department to supply the needs of aviation has been developed by the International Derrick & Equipment Co., with offices here and at Torrance, Calif.

Puts Out Treatise On Fuel Efficiency

MICHIGAN CITY, Ind.—How to obtain higher efficiency and lower fuel bills is explained in an eight-page treatise on "Combustion Trouble-Shooting," by The Hays Corp., manufacturer of combustion instruments for reducing fuel bills. It has been published for the benefit of those who are interested in how and where to locate, analyze and eliminate fuel wastes. It illustrates the Hays portable combustion test set which comprises flue gas analyzer, flue gas thermometer, draft gage and necessary accessories.

These additional representatives have been appointed recently by the company:

S. Thomas Engineering Co., St. Louis, for eastern Missouri and southern Illinois; Joseph H. Spurgeon, General Motors Bldg., Detroit, Mich. for eastern Michigan and northwestern Ohio; H. R. N. Johnson, New York Life Bldg., Minneapolis, for Minnesota and the Dakotas; and Louis Towner Construction Co., Grand Rapids, Mich., for Grands Rapids and contiguous territory.



Below, boiler house which houses boilers, shown at left

Fig. 1—Left, an installation of four 1000-horsepower oil-fired water tube boilers

Boiler House Engineering In Oil Industry

By Elmer J. Dreyer

STEAM is not only indispensable in refining processes but in some cases forms the largest single item of expense and its economical generation and use is essential in reducing production costs. Economy in the production and use of steam is directly dependent upon the efficiency of each and every unit or apparatus involved, and can only be accomplished by correct design, efficient operation, and continued supervision.

Refineries are peculiarly adapted to unit construction, so the smaller ones have about the same advantages as the larger ones in economical design, operation and management. However, the large refinery, for no economic reason, is generally found more properly equipped with both apparatus and operating force to produce the results necessary to lower costs.

Primarily, then, this article is written for the benefit of the smaller plants and also for those where better operating results should be obtained. First, let us look at some modern steam generating stations now operating in refineries.

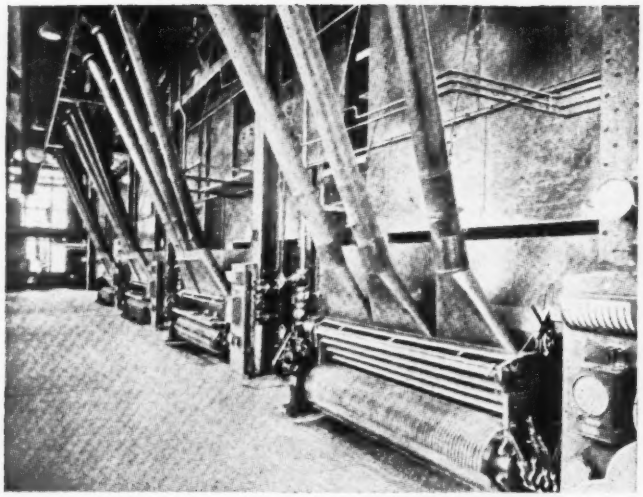
Figure 1 shows a modern installation of four 1000-horsepower boilers. They are located in the Texas field and are oil fired.

Figure 2 shows four 755-horsepower boilers in an Ohio refinery. They are operated with chain grate stokers, using a low grade of coal. The coal is fed to the stokers from an overhead bin which is filled by bucket cranes from the yard storage on the outside of the building. You will note the recording and indicating instruments in the boiler room conveniently located for observation by the operating force.

The plant shown in figure 3 is located in Missouri and contains twelve 500-horsepower boilers. These boilers are also fired with coal, but the method of handling the fuel is somewhat different. In this case the loaded coal cars are drawn up an inclined trestle by cable and are emptied into the large capacity bunkers from which the coal is fed directly to the stoker hoppers.

LOCAL conditions influence to no small extent the selection of the equipment and the general layout of the plant. Where labor is scarce or outside storage capacity is limited, this arrangement is quite economical, although it is more difficult to make repairs to the boiler when it is necessary to gain access to the front. The use of a coal bunker such as shown in figure 2 would alleviate this condition, but due to poor transportation facilities it was necessary to provide a much greater storage capacity.

One of the latest and most modern installations of steam generating equipment in an oil refinery is shown in figure 4. This plant,



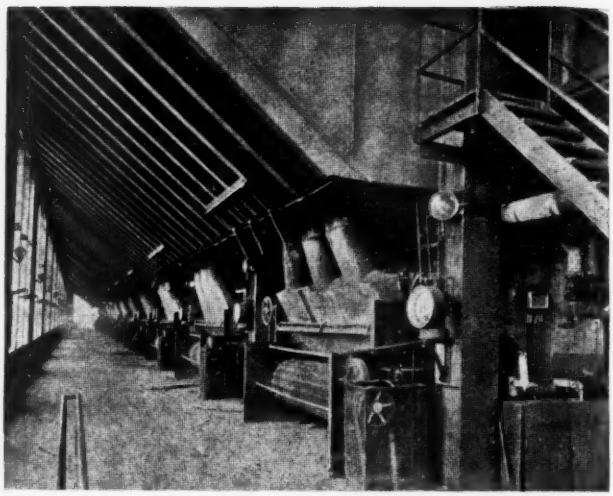


Fig. 2 at left, four 755-horsepower water tube boilers. Fig. 3, at right, an installation of 12 500-horsepower water tube boilers

located in Illinois, and representing at present a refinery of medium size, contains three 526-horsepower boilers fired by forced draft chain grate stokers and arranged to give a high heat balance and high plant efficiency.

Briefly, steam is generated in the boilers at 275 pound gauge, superheated to 615 degrees and delivered to the throttles of combined bleeder and mixed flow type turbines. After passing through the impulse blades of the turbines it is bled out at 125 pounds and transmitted through steam lines for general use and process work in the refinery.

Condensation from the entire plant is drained back to a large tank in the power house and refed to the boilers, while the non-condensed steam is passed at about 1 pound pressure through the low pressure stages of the turbines to surface condensers. This condensate is also drained back to the feed water tank. As the amount of makeup water required is small, the boiler feed water, except for the makeup, remains free of scale forming and other soluble and suspended solids. To remove these solids from the makeup water, it is treated in a single effect evaporator operated with steam at 125 pound pressure. Theoretically, water from evaporators should contain no solids, but in practice the distillate will contain usually from ¼ to 1 grain per gallon. This is not objectionable as it prevents the tendency of the distilled water to cause pitting.

THE feed water is supplied to the boiler by two centrifugal boiler feed pumps, one motor driven and one steam turbine driven. Service water for the plant is supplied by duplex steam pumps. An automatic arrangement from the service lines is used to maintain a constant level in the feed water tank in case the makeup water necessary exceeds the capacity of the evaporator.

The circulating water for the condensers is cooled in a spray pond and recirculated by centrifugal motor driven pumps.

Most of the driven apparatus in the plant is operated by motors so that the electrical load on the turbines will be sufficient to supply all of the 125 pound steam required in the refinery. If the electrical load drops below this point, however, the deficiency is made up from the high pressure lines through an automatic reducing valve.

THE steam in the low pressure line when supplied from the bleeders is preheated about 150 degrees and varies up to 230 degrees if supplied entirely through the reducing valve. All of the electric current used in the plant is generated by turbine generators at 440 volts, 3 phase, 60 cycle.

Under normal operation, the main throttles to the turbines can be closed and the return supply from the low pressure line to the low pressure stages of the turbines will be sufficient to generate about 35 per cent of the total load. Each turbine has a surface condenser equipped with a two-stage air ejector with inter and after cooler.

This boiler installation is one of the most modern in the Central states. The boilers are fired by steam driven chain grate stokers capable of burning enough coal to produce 350 to 400 per cent rating, accounting for boiler heating surfaces only. Such high rates of combustion with coal properly burned creates very high furnace temperatures. To reduce the cost of repairs to the brickwork in the furnaces, the side walls are protected by fin water tubes connected to the boiler circulation. To get better combustion of the low grade coal used, and to maintain high furnace temperatures for ignition, the air for the stokers is preheated. The counter current air heaters are of plate construction, and take their air, through forced draft fans, from around the breeching compartment located below the boiler room floor.

The air for combustion receives initial heat from the breeching and after going through the heaters reaches the stokers at about 300 degrees F. The flue gas temperature is reduced by the exchange of heat in the air heaters to about 280 degrees at the stack. This temperature is too low to produce the necessary draft for the boiler, so the gases are handled by induced draft fans placed between the air heaters and the breeching.

The boilers are equipped with soot blowing elements. Due to the load which the boilers carry, the rate of coal consumption is high, and with the grade of coal burned the soot blowers are operated every four hours to insure clean outside heating surfaces. At the same intervals of time the operator is required to blow down each boiler slightly. The operators are provided with all the necessary instruments and control devices to maintain high efficiencies.

AUTOMATIC feed water regulators handle the rate of flow from the feed water tank to the boilers, and a differential pressure of about 40 pounds between the feed water line and the boiler pressure is maintained. Automatic combustion control apparatus maintain the proper rate of combustion to support the load carried by the boilers. CO_2 indicating and recording meters and boiler meters provide the operators with means of determining the proper and most efficient method of handling the various loads which the plant is called upon to carry. Feed water meters for each boiler and coal weighing devices provide the means of keeping efficiency and economy records of the plant over any interval of time.

Recording steam pressure gauges, recording thermometers for flue gases, preheated air, saturated steam and superheat complete the auxiliaries and

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appurtenances which make this plant a model installation for future plants to strive for.

These few examples serve to indicate the application of advanced engineering principles and methods to the generation and use of steam in the oil industry. They compare very favorably to modern central station operation, in fact considering the almost complete recovery of heat from low pressure and exhaust steam in heating and process work, their overall plant efficiency is very much higher. The most highly developed central station steam plants utilize about 20 per cent of the heat in the fuel, as compared with about 60 per cent in plants where all the heat in the steam is made to do useful work. The difference between the total heat in exhaust steam and steam at 250 pounds pressure is less than 5 per cent and the refinery plant cannot only extract power from live steam in the process of reducing its pressure but utilize the heat in the exhaust or low pressure for steam manufacturing purposes, thus getting a very high heat balance and high plant efficiency. The need for good steam generating equipment is apparent.

There are many uses for steam in the various types of refineries besides the generation of electrical energy for power and light. Large quantities are used in steam stills, sweat pans in paraffin plants, cracking processes, oil and water pumps, steam fire pumps, air compressors and many other apparatus and processes. The small refinery uses as much steam in proportion to manufactured product as the large refinery, and their need for efficient steam equipment is the same. The large plants use water tube boilers exclusively, but in the smaller plants the question often arises as to advisability of using the water tube or the fire tube (horizontal return tubular) boiler. In present practice and with the modern type of water tube boiler installation insuring the possibility of very high efficiencies, the fire tube boiler is considered obsolete in plants over 200 horsepower capacity.

DUE to its construction, the fire tube boiler does not lend itself to any flexibility in design or any improvements tending to make it compare with the water tube boiler in operating efficiency. It is limited in size and pressure because of the rapid increase in plate thickness with the diameter and very few are built for pressure above 150 pounds. It has no definite circulation and its steam storage space is small so that it has practically no overload capacity, and the steam delivered from it is usually very wet. It is hardly accessible for internal cleaning and with the quality of feed water generally used in this kind of installation, scale accumulates on the heating surface and reduces the rate of heat transmission considerably. The lack of circulation and the comparatively short length of gas travel also prevent the high heat absorption necessary for economy, and with scale deposits added to only an initially fair heat absorbing surface, the efficiency of the fire tube boiler can become so low as to be all out of proportion to its comparatively lower first cost.

The ever present danger of terrific explosions with the fire tube boiler should not be overlooked. The files of boiler insurance companies are full of reports on fire tube boiler explosions, most of which cause very heavy property damage and loss of life. Imagine the possible damage from such an explosion in an oil refinery. There is probably no refinery that does not overload its equipment at certain times. With boilers, overload means higher furnace temperatures and if scale is allowed to form on the shell of a tubular boiler fired with oil or any other fuel producing high furnace temperatures it is an easy matter thus to overheat the shell plate, cause it to rupture, and release the enormous, expansive, and destructive power within.

The science of steam generation has undergone considerable changes—developments and improvements have been quite marked in the last few years. The demand for the economy of higher pressures, higher generating capacities, improvements in fuel burning apparatus and the development of powdered fuel has necessitated new and improved designs of water tube boilers. Rapid water circulation through clean heating surfaces becomes necessary to obtain maximum heat absorption. It is more necessary that heating surfaces be so arranged as to receive the greatest possible benefit by the absorption of radiant heat projected from the furnace. Fully effective gas passes through the heating surface and long gas travel are necessary to reduce the exit gas temperature and the boiler must have a high steam generating capacity while eliminating priming and the delivery of high percentages of moisture in the steam.

These changes have involved other problems. With high pressures and capacities the temperature of the exit gases automatically increased and led to the necessity of changes in the design of economizers with the development of air preheaters. To maintain high efficiencies with the increase in flue gas temperatures, the installation of economizers and air preheaters is becoming increasingly necessary. High furnace temperatures incident to the increasingly high rates of combustion, cause the rapid deterioration and destruction of furnace linings and have resulted in the development of air and water cooled walls.

FURNACE temperatures can be lowered to some extent and as consistent with complete combustion by exposing as much of the heat absorbing surfaces of the boiler as possible to the radiant heat from the furnace.

The present requirements for water tube boilers which will meet the demands for high steam generating capacities, sudden and high overloads, and still maintain economy and efficiency, involve the consideration of

E. J. DREYER

Mr. Dreyer, the author of this article, received his engineering training at the University of Wisconsin and in 1911 *entered the employ of the United States Steel Corp. at Milwaukee as assistant steam engineer. He was transferred to the South Chicago plant in* 1915 *as steam expert and for three years was occupied in making investigations for the improvement of power plant economies including the combustion of coal under locomotives of the E. J. & E Railroad.*

From 1918 *to* 1922 *he was technical adviser for the Central States on special work in the power division of Johns Manville, Inc.*

He has been connected with the Henry Vogt Machine Co. since 1922, *specializing in industrial power plant layouts, is a member of the A. S. M. E.*

several important factors besides those already mentioned.

Simple construction with high quality of material and workmanship; elimination of expansion and contractor stresses; accessibility for inspection, cleaning, and repair; ease of operation and maintenance; and adaptability to the load conditions to be imposed, all are involved in the plant economy of any particular installation.

Referring again to figure 4, which represents up-to-date practice, you will note the compactness and accessibility of the boiler house equipment. The boiler is of the bent tube three drum construction. The tubes are all bent to the same radius on long easy curves. There are but three openings necessary, one in each drum, to gain access to the interior surfaces. The tubes are all arranged so that any one tube can be removed without disturbing any other, and numerous inspection doors in the setting, some of which are of the automatic relieving type, make the outside surface of the tubes as well as the brickwork easily accessible.

The design of the water circuit is such as to embody the ability for quick steaming; give unrestricted and positive circulation, and deliver steam practically free from moisture. The possibilities of high percentages of moisture being delivered from this boiler by priming or spouting action are practically eliminated since about 85 per cent of the steam generated is delivered to the front drum and must pass through the top steam drying tubes and the rear drum before entering the nozzle.

Rapid, unrestricted, and positive

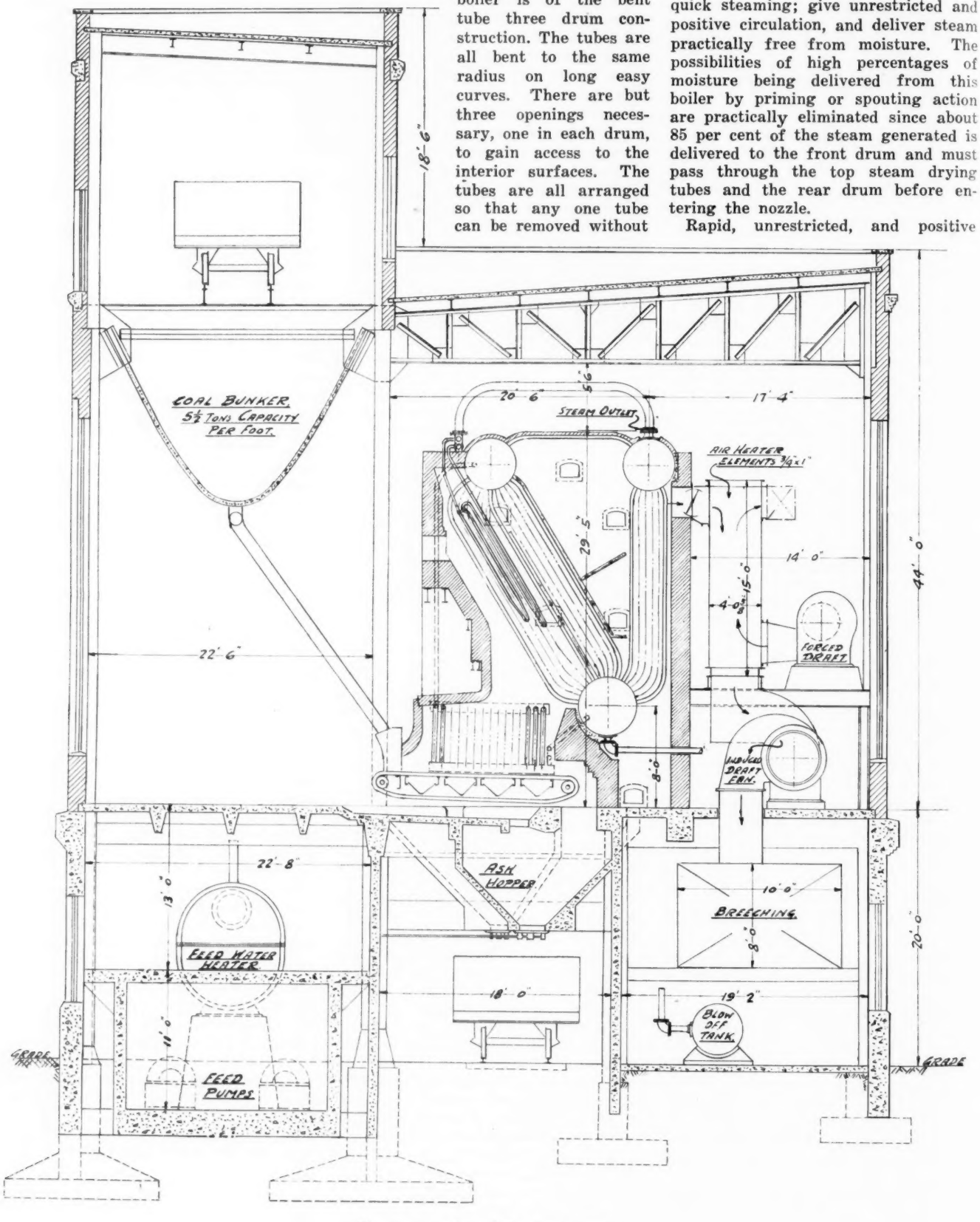

Fig. 4—A modern boiler house layout

circulation of the water occurs through the circuit comprising the first two banks of tubes and the drums to which they are connected. The feed water enters the rear top drum and in descending the rear bank of tubes is heated to approximately steam temperature before entering the more rapid circulating and steam generating surface.

The gas passages are fully effective and permit of long travel of the hot gases of combustion. There are no dead spaces where heat from the gases may be dissipated to other than the heating surface, and the gas areas are of such proportion as to eliminate high draft losses. The floor space necessary for this type of boiler is about the least possible per horsepower.

In figure 4 the boiler is fired with a forced draft chain grate stoker which requires an ignition arch to ignite the coal as it enters from the hopper, but inasmuch as incandescence does not occur until the coal has reached nearer the center of the grate it will be noted that the maximum heating surface is exposed to the radiant heat from the furnace.

In figure 5, which represents a smaller boiler of the same type, is shown a furnace adaptable to oil firing. The oil burner shown is of the steam atomizing type and produces a flat spreading flame. The steam and oil pipes to the burner and the air required for combustion are led down through the hollow front and under the floor of the combustion chamber where the heat from the brickwork not only keeps the steam and oil lines hot but preheats the mixing air and reduces the length of flame travel by producing more rapid combustion. The furnace is amply large for high rates of combustion and the tube surfaces in the front bank are exposed for practically their full length to the radiant heat in the furnace. This installation is carrying continuous loads of 200 per cent rating (figuring 10 square feet of heating surface per horsepower) and demand or peak loads of 300 per cent rating, and generating steam with less than ½ of 1 per cent moisture at the steam nozzle.

FIGURE 6 shows this boiler equipped with an underfeed stoker. In this type of fuel burning apparatus the entire top surface of the fuel bed is incandescent, the fresh coal being fed from beneath the fuel bed and the volatile gases burned in passing up through the coked and burning coal. This method of firing eliminates the necessity for arches and here again the entire length of the front tubes is exposed to radiant heat. As evidence that this boiler is a very efficient heat absorber, it is not unusual for it to raise full pressure and discharge the safety valves when the brickwork of a new installation is being dried out with a smoldering wood fire.

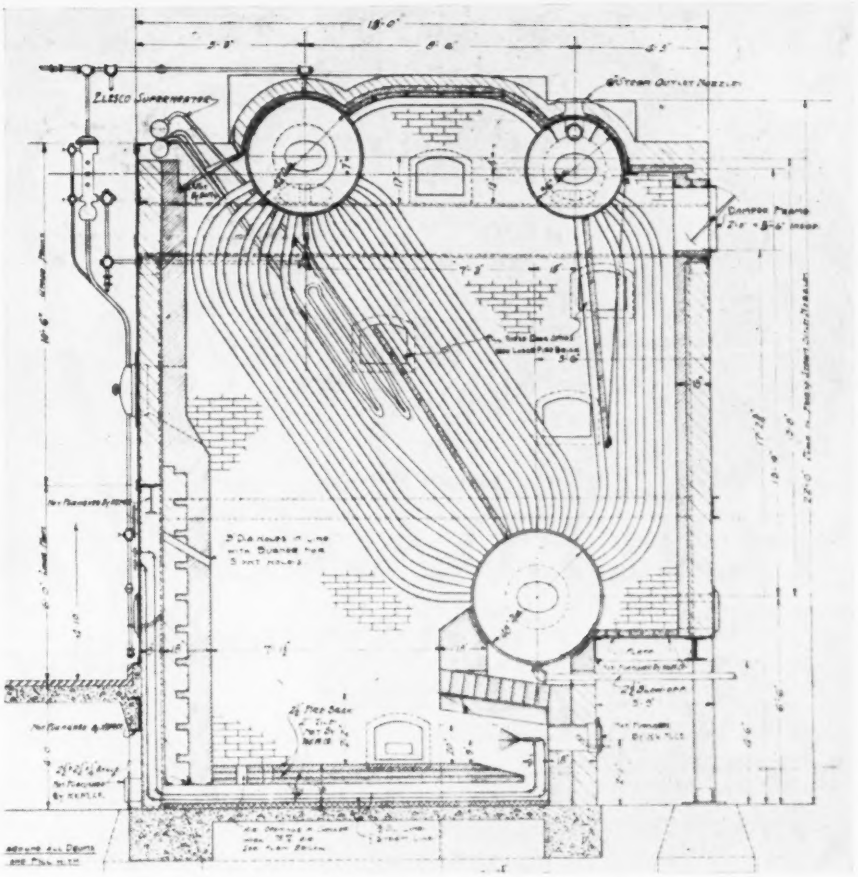

Fig. 5—A small water tube boiler and furnace adapted for oil firing

Figure 7 illustrates another type of boiler in which the principle of ring flow circulation is employed. The flow is natural and, as there are no restricted passages, a high water velocity is obtained. The greater the velocity of water in circulation, the greater the rate of heat transmission and with the baffling arranged for four passes of the gases of combustion, this boiler will operate at high ratings with comparatively low flue gas temperatures. There is only one point in the gas travel where the gases are required to make the usual 180 degree change in direction and that is in a low temperature zone where their volume is naturally reduced. Consequently the draft loss is less than with other types of construction operating at the same rating. The top steam drum and its connecting tubes are entirely above the water line and subjected to radiated heat from the second pass so that the steam liberated from the water surfaces is dried and slightly superheated on its way to the outlet nozzle. The steam generated in the first bank of tubes is liberated in the front drum and passes through the front connecting steam tubes where the entrained moisture is evaporated and superheat added. The remainder of the steam, liberated in the rear drum, is similarly treated in the rear steam tubes.

The superheat developed by the boiler is not intended to replace the superheat generated by standard makes of superheaters where high degrees of temperature are desired for prime movers, but in plants where saturated steam only is used this slight superheat eliminates the waste of drips and greatly reduces pipe line and cylinder condensation. Then, too, as mud, silt and foreign matter can only be carried by the moisture suspended in saturated steam, a slight superheat eliminates the carrying over of these highly abrasive solid particles which do so much damage to valves, cylinders, linings, etc., and makes unnecessary the installation of steam purifiers. The first few degrees of superheat are the most effective and the gain in efficiency by their use is many times the difference in available energy.

ANOTHER distinguishing feature of this boiler over other types is the liberation of steam as it is generated in each bank of tubes. It is particularly advantageous to liberate the steam generated in the front bank, which produces 70 per cent or more of the total delivered by the boiler, through the front drum connection and relieve the second bank from the burden of carrying this large volume. It also allows a much higher heat absorption in the second bank as these

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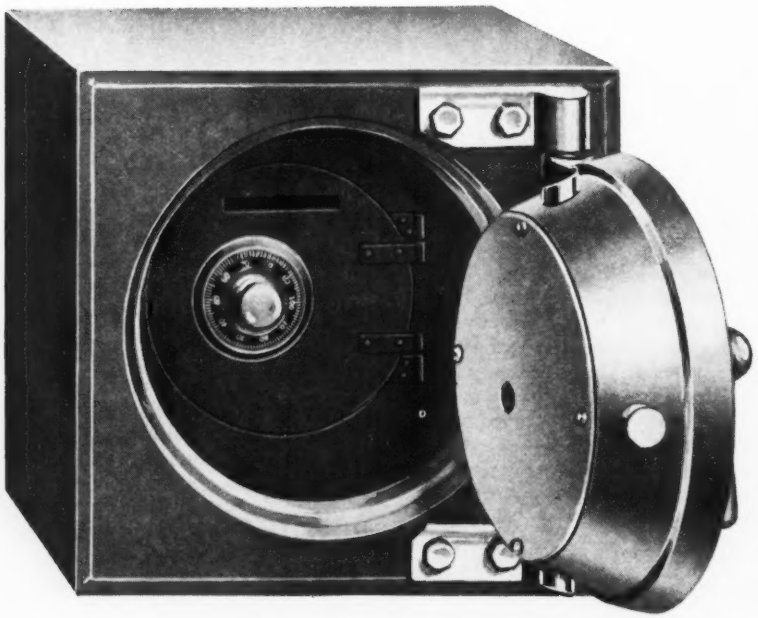

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tubes carry only the water remaining in circulation and the rate of heat transmission from gas to water is considerably higher than from gas to gas.

Large liberating and endurance surface areas in the boiler give easy and quiet liberation of steam and the steam and water circuits are so arranged that a balanced pressure is always maintained in the front and rear drums insuring a steady, even water level. These features are so essential to the economical generation of steam and the elimination of serious water fluctuations at high ratings.

TO BUY steam generating equipment is one thing—to generate steam economically with that equipment is quite another. For the first, careful consideration must be given to the proper selection of equipment to meet the particular conditions under which it must operate. Conditions vary in different plants and in different localities. The manufacturing process in one plant may be such that the steam demand is fairly constant while in another the load may be constantly changing and the steam demand widely fluctuating. Equipment that will be economical in one case may be a very poor investment in the other. It may be better to install two or three large units—or several smaller ones. Where plants are situated at a considerable distance from the coal fields, the transportation charges may be prohibitive for the use of coal as fuel and residual oil from the refinery is used instead. Where the cost of a certain number of B.T.U.'s delivered to the heating surfaces of the boiler by the combustion of coal is less than the cost of the same number of B.T.U.'s delivered to the same place by the combustion of oil, including all the necessary charges such as transportation, handling, depreciation on the equipment used to produce the B.T.U.'s, interest on the investment, etc., it would be folly to burn oil.

If coal is used for fuel the available supply may be of such a grade that only one kind of firing apparatus could be used to burn it economically. Again, the most economical capacity at which to operate a plant is a variable depending on the class of equipment, arrangement of the units and the auxiliaries, load conditions, class of fuel and its cost, etc. So, the conditions surrounding any particular installation create an individual problem and its solution can only be ascertained after a thorough investigation.

Some purchasers give their first thought to the initial cost of the equipment rather than to the most important consideration—the cost of producing steam. Others simply buy equipment with which they are familiar or with which they have had some experience and no particular difficulty, assuming it to be an economical and efficient steam producer under their present requirements. The cost of producing steam is debited on the ledger daily and in the life of a poorly selected plant can total a tremendous amount which is directly chargeable to the first item of initial cost. The selection and arrangement of equipment should be left to those whose experience and judgment makes them aptly fitted to assume the responsibility. The larger plants have their own capable engineers; the smaller plants must rely on those in whom the management has confidence.

FOR the second, to generate steam economically after the number and size of the units for handling the load factor has been determined and the type of units selected, it is necessary to correctly coordinate the component parts—boiler, firing apparatus, and furnace. The furnace should be so designed and constructed as to give the best results with the kind of fuel and firing apparatus to be used and the ratings to be obtained. It should be sufficiently large and of such form that combustion is practically completed before the gases reach the heating surfaces of the boiler, and necessitates ample room for flame travel. More combustion space is required for oil and pulverized coal than for hand or stoker firing as the carbon particles are burned in suspension and the velocity of injection with the time required for complete combustion produces longer flame travel. From ½ to 1½ cubic feet of furnace volume per developed horsepower should be allowed for hand or stoker firing, depending on the grade of fuel. For

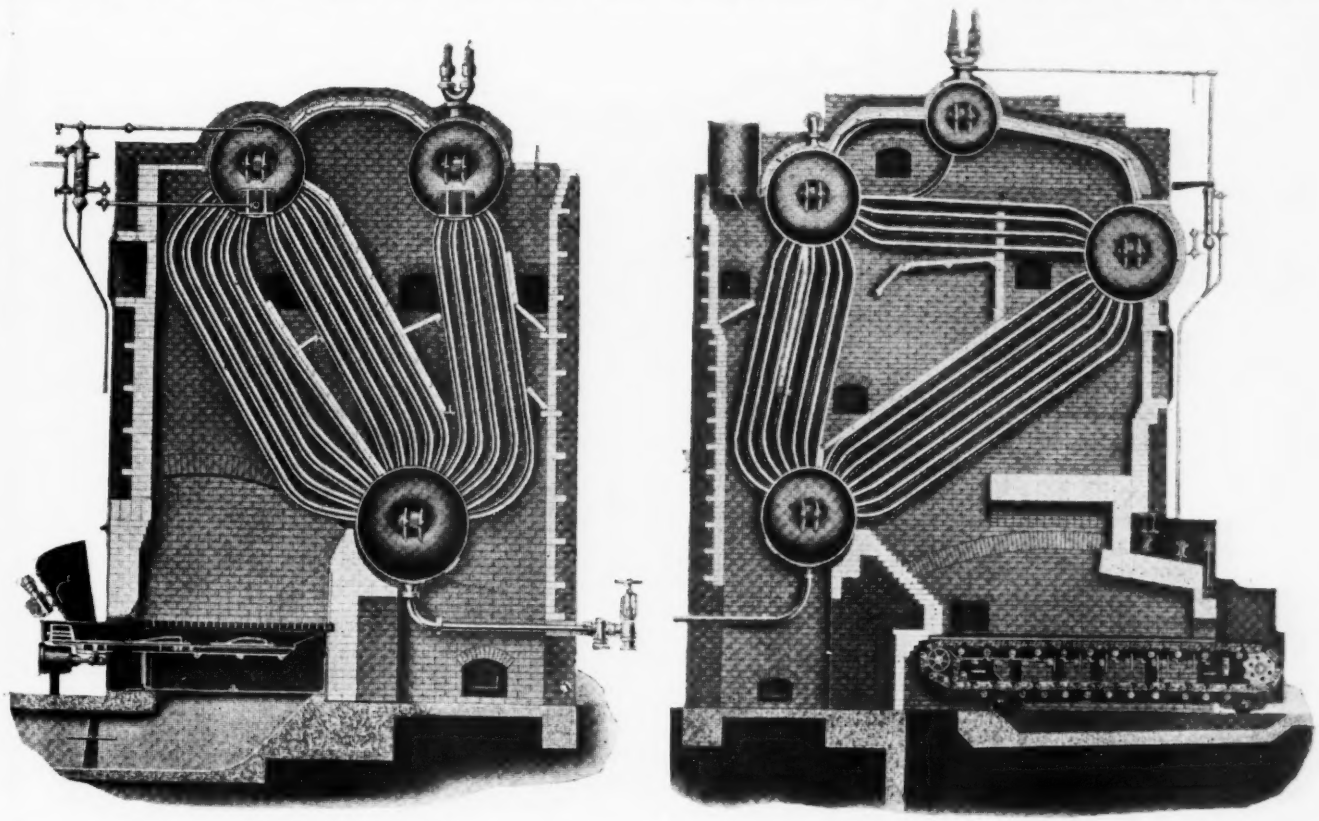

Fig. 6, at left, shows sectional view of boiler equipped with underfeed stoker. Fig. 7, at right, shows a boiler in which ring plant circulation is employed

oil or pulverized coal 1½ to 2½ cubic feet is necessary.

The firing apparatus will have been chosen to give the best results with the kind and grade of fuel available and the combustion rates necessary to carry the required load on the boiler. That will decide the number and size of the burners if oil or pulverized coal is used or the size and proportion of the grates if hand or stoker fired and whether forced draft equipment will be necessary. It should then be so arranged in conjunction with the furnace and with regard to the burning characteristics of the fuel that ignition temperatures will be maintained, thorough mixing of the combustible gases and air is accomplished, the gases distributed uniformly and the performance of the apparatus be maintained at maximum efficiency. The firing apparatus and the furnace are so intimately correlated that consideration of either can hardly be taken without involving the other.

Next, and lastly, the boiler heating surfaces should be so arranged and distributed in conjunction with the stoker and furnace as to absorb the greatest amount of heat from the gases of combustion. Absorption efficiency is a matter of water circulation and sufficient heating surface area, properly distributed, and may be obtained by correct co-ordination. The front surfaces should be exposed to the furnace as much as possible so the maximum amount of radiant heat, consistent with complete combustion, will be transmitted to the boiler. The gas passages through the boiler should be without dead spaces so that all heating surfaces can absorb heat effectively, and without pockets to harbor accumulations of soot. Gas travel should be long to allow the time element necessary to accomplish efficient reduction in temperature of the gases and at the same time the gas velocity should be high enough without too much loss in draft, to give a high rate of heat transmission.

THE auxiliaries necessary to complete the installation may be finally considered, but as the name implies, their co-ordination is not such a problem and can readily be accomplished. If the plant is to be operated at high capacity entailing high combustion rates with automatic control, the furnace temperatures may become so high as to cause rapid deterioration and destruction of the lining by the spalling action due to the adhesion of slag or by the fluxing action of molten ash having a low fusion temperature or by their own spalling and deformation under high temperatures and the side wall loads carried. It would be economical, and no doubt necessary, to install water cooling surfaces in the furnace to reduce the temperature and protect the lining. The increased rate of steam generation increases the temperature of the flue gases considerably, particularly when the plant is operated at high pressure, and to maintain the same efficiency as at lower pressures and ratings, economizers or air preheaters or both should be installed, depending on their economic value in the particular instance.

ALL boiler installations should have some means provided for removing both soot and scale from the heating surfaces. Dirty boiler surfaces cannot absorb heat readily and high stack temperatures and low efficiencies are the result. In any plant where other than waste products are used for fuel it pays to install devices for the automatic control of the feed water, regulation of the air supplied for combustion, and the rate of feed for the fuel. The returns to be derived from their intelligent use are continuous and many times their initial cost. To furnish the means for determining the efficiency of any operating unit and to furnish the necessary guides for the continued checking of operating results so that the efficiency can be held as near as possible to the highest point, it is necessary to install indicating and recording instruments. These include recording steam or feed water meters, or both; recording steam pressure gage, recording thermometers for flue gas temperatures and for superheat, if superheat is used; recording CO_2 meters; measuring devices to weigh the amount of fuel used; indicating draft gages registering draft at the furnace and the damper and an Orsat for optional analysis of the gases of combustion.

It might be well to consider here the feed water and its treatment. It has always been an important factor and is becoming increasingly more important because of the present demand for higher steam pressures and higher rates of evaporation. Good feed water should contain no scale forming solids or suspended matter to cause priming and foaming or noncondensable gases to cause corrosion. Raw feed water should be treated outside of the boiler and when it contains 10 grains or more of hardness should generally be treated with some form of soda ash and lime or soda ash and barium treatment with the possible additional of a small amount of sodium aluminate in the hot process treatment. If less than 10 grains it can be successfully treated with a cold process Zeolite method. This method is not exactly adapted for very hard water because of the high concentration of sodium compounds. Any chemical treatment, however, allows soluble solids to remain in the water and they are left behind in the boiler when the water is evaporated, causing concentration in proportion to their content in the water and the amount of water evaporated. To deconcentrate, the boilers must sometimes be blown down very frequently and taken off the line and drained after short runs. Blow downs become more necessary of course with higher ratings due to the increasing concentration. For good practice, the allowable concentration is 300 to 500 grains of solids per gallon. With hard water of, say, 25 grains original solids per gallon, it is necessary to blow down from 5 per cent to 7 per cent of the water fed to the boiler to keep within this concentration limit. This amount of blow down, if allowed to drain to the sewer represents a very great heat loss and sometimes in cases of this kind continuous blow-down systems are installed which reclaim the heat in the discharge by transmitting it back to the feed water through a heat exchanger. Refinery plants should feel fortunate in that it is possible for them to return most of their condensate, which is practically free of all solids, and it is only necessary to treat a small percentage of make up.

Now we come to the most important element involved in the successful and economical operation of the steam generating plant—the human element. Power plants today are more complex and costlier than they were a few years back. As stated before, higher pressures, higher rates of evaporation, higher combustion rates, improvements in the design of equipment to keep pace with these advances and the increased cost of fuel have greatly enhanced the importance of the boiler house, and complicated its supervision and management. This is more true in the oil refinery than in many manufacturing industries, so the refinery which does not have competent men supervising the operation of such a costly part in their manufacturing process may be charged with negligence of the worst character. To produce efficient results from any steam generating plant, it must be supervised by skilled operators technical enough to understand the operation of every appliance installed and see that they are properly applied and controlled, and kept in good condition.

A POORLY designed plant may be made to give fairly good results with careful attention. If the boilers are old or are not arranged properly to give the results desired, it might be possible to add one or two new units designed and co-ordinated to give high efficiency at moderately high generating rates and let these new units carry the heavy and fluc-

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tuating part of the plant load while the old boilers float on the line carrying that constant part of the load at which they can be most efficiently operated. If the boilers are set so that the stack temperatures have become too high with an increase in the load, the addition of an economizer or air preheater will probably more than restore their economy.

If any appreciable amount of high pressure steam is being used for process work where low pressure steam would be as satisfactory, it might pay to install a back pressure turbine or engine or a bleeder type turbine and extract power from the live steam in reducing its pressure before piping it on to the process work.

However, rehabilitating existing plants is an individual problem, and each case must be thoroughly investigated before any definite recommendations can be made.

A properly designed plant will give poor results with careless handling—a poorly designed plant may be made to give fairly good results with careful attention—but the properly designed plant in its rightful place of importance, carefully managed, supervised and operated by competent men getting good salaries and wages, working in well lighted airy and clean surroundings, is the one that pays the dividends.

Process Will Resist Corrosion, Claim

Cleveland, O.—In an effort to overcome difficulties arising in the construction of chemical engineering equipment, which must be lead-coated to resist corrosion, Louis Gross, of the Gross Lead-Burning and Coating Corp., Cleveland, has developed the Gross formula lead coating process.

This process uses a special formula flux which opens up the pores of the metal and permits the application of a thin permanently adhering coat of pure lead upon which further layers may be built. The outstanding feature is, according to the company, that as it is not necessary to use other metal to make the lead adhere to the surface to be protected, the electrolytic and other actions are eliminated.

Where hot solutions are used the process resists to a greater degree the strains due to contraction and expansion due to variations of temperature, it is claimed.

Another new development by the company is a lead-lined drum for shipping sulphuric and other acids. It has been approved by the drum committee of the Manufacturing Chemists Association and by the Interstate Commerce Commission, and was made in conjunction with the Republic Steel Package Co., Cleveland.

It is claimed that the drum will resist very severe mechanical stresses as well as heat up to its melting point.

Necessity Brings in Engineer, Improving Natural Gasoline Manufacturing

By W. A. Melton*

THE old adage, "Necessity is the mother of invention" has been responsible for the engineering advances in the natural gasoline branch of the petroleum industry. Through necessity, the gasoline business was the first to draw into it the engineers of the petroleum world, due to the rapid increase in production from the comparatively recent beginning of the business to the present time. For example; production of natural gasoline actually increased 381 per cent between the years 1918 and 1926. This increase is the more remarkable when compared with the increase in production of refinery gasoline which in the same period was only 273 per cent in spite of the fact that most of the advances in cracking processes took place during this same period.

This rapid increase in production of natural gasoline has brought with it a number of "growing pains" which have caused considerable distress to the business at different times and will undoubtedly continue to cause distress, more or less frequently, for some time to come.

While these growing pains have been and are very annoying at times, yet, I think they can be classed as blessings in disguise, as the business has always emerged a stronger and healthier youngster after one of these attacks.

For instance, the problem of overproduction brought with it low prices, making it absolutely necessary that the business of manufacturing gasoline be put on an efficient basis, which of course, gave the engineer his chance to step in and see if there were not some ways to improve methods of recovery, both as to equipment used and the product being manufactured. Some of these improvements are worthy of special notice.

In the beginning of the gasoline business the recovery plants were very crude, using the compression method, which consisted in boosting the pressure to 200 pounds to 300 pounds and cooling the gas to as low a temperature as possible, thus causing the gasoline elements in the gas to condense in tanks, from which they were drawn off to storage. This process was necessarily very inefficient and expensive and the product recovered was of poor quality, due to the dissolving of permanent gases in the gasoline, which were responsible for the bad name "casinghead gasoline" recognized throughout the refining world during the first few years of the business.

Following this period, most refiners refused to use "casinghead" at all and as the methods of blending were not as well known then as now the natural gasoline men found themselves in a very bad way, and to protect their investment they began to investigate to see if it were not possible to make a product that would meet the demands of the public. As a result, the Association of Natural Gasoline Manufacturers came into existance and the problem of improving the product was attacked in earnest.

The result has been a constant improvement in natural gasoline until at the present time all natural gasoline is sold according to grades. These grades have been changed from time to time as methods of manufacturing have improved. On Oct. 1, the association will announce new specifications which will require all natural gasoline to stand the corrosion test as well as to meet a specified recovery.

It is indeed a far cry from the wild days of the Ardmore and Memphis disasters to the day when Art. Goebel flew the "Woolaroc" 2,400 miles across the trackless Pacific, from California to Honolulu, using straight natural gasoline—where the continuous operation of the engine meant life, and failure of his fuel for even a minute meant certain death.

All these improvements can be credited to the skill and endless effort of the engineer in the natural gasoline industry, coupled with the faith and foresight of the manufacturers.

The work on improvement of natural gasoline has been so successful that at least two companies now are about to place on the market a finished motor gasoline, suitable for all automobile and airplane uses.

The improvements in products have been, of course, the direct result of better equipment used in gasoline plants and better methods of operation.

The old type compression plant, making as low as 500 gallons per day, has almost disappeared and in its place we see the present type absorption plant with its almost unbelievable production of from 50,000 gallons to as high as 100,000 gallons per day.

Even at the newer absorption plant, the engineer has not been content to stop but has constantly improved the equipment until we see the present bubble type absorber taking the place of the old makeshift tower filled with steel turnings or wood grids and the old horizontal tank still replaced by the present fine and efficient vertical type bubble still or the direct fire still.

EVEN the old pipe coils have been replaced to a greater or less extent by the modern enclosed type coolers. Where we once saw the old inefficient line shaft with its countless belts driving pumps and other auxiliary plant equipment or the old steam pumps, we now see the modern and efficient electric generator and the individual motor driven pumps and auxiliary apparatus.

In the past two or three years a very interesting development in the small plant field has taken place and we now have the portable and the semi-portable plants which can be placed in a new oil field and gotten into operation in considerably less time than the old type permanent plant. These plants have considerable merit but should not be considered as replacing a permanent plant except in very special cases.

The charcoal plant is also a very interesting development on a commercial basis in the past few years and bids fair to become a factor in the business as time goes on.

The improvement of quality in products has been due probably more to improvements in methods of fractionation of the gasoline than to any other one agency. We now have the fractionator or "stabilizer" which, by heating the liquid to any desired temperature and by driving the released vapors up through a tower where the temperature is kept extremely low (even as low as 0 degrees Fahr. to 10 degrees Fahr.) the desirable components can be recovered and the so-called "wild" gases are released, thus giving a product of exceptionally high gravity and very high recovery

To sum up the above discussion, it can be said that the engineer in the natural gasoline business is constantly on the alert to find by research methods by which the recovery of gasoline from the gas can, in the first place, be made more complete and also methods by which the gasoline, after being removed from the gas, can be improved in quality to keep its place in the present and ever increasingly more competitive field of consumption.

*General superintendent, gasoline department, Shaffer Oil & Refining Co.

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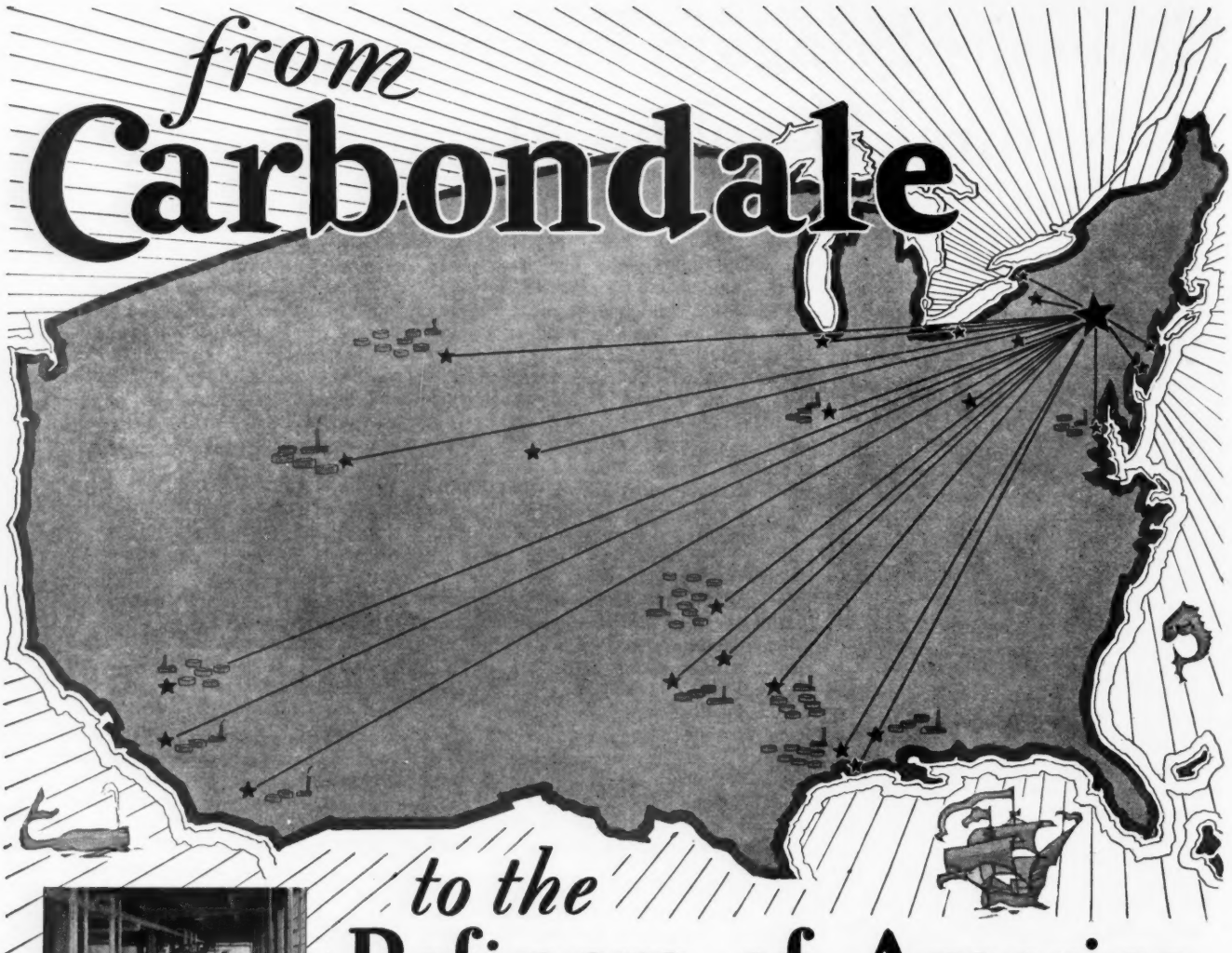
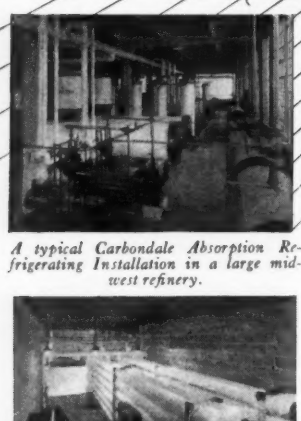


to the Refiners of America



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Application of Automatic Controllers To Natural Gasoline Manufacture

By Emby Kaye

THE field of application of automatic controllers to the manufacturer of natural gasoline has, in the last few years, been greatly extended and their value is now very well recognized.

Whenever a process or an operation varies, even the slightest amount, due to natural changes of operating conditions, there is very often a tremendous effect, either direct or indirect, on the specifications or cost of the finished product. Where these conditions exist, a correct type of automatic control can be applied with the confidence that the uncertainties of the human element will be abolished and that production will be greater, and the product more uniform and more economically produced.

Probably the most common type of control with which most operators are familiar, is the knock-out temperature controller. Too high a temperature makes for a high end, possibly off-color, product; while, with too low a temperature, too light a product is made, and the chances are that plant efficiency has further been reduced by keeping the heavy ends in the oil with the result that the vapor pressure of the oil is materially higher.

The real problem confronting the purchaser desiring to obtain the best results with automatic control, is the compiling of engineering data enabling him to decide what processes need to be controlled, to what degree they must be controlled, and the selection of proper instruments, having proper size controlled valves, which will enable him to maintain this degree of control regardless of varying operating conditions.

Probably the greatest cause of unsuccessful applications of automatic control is the lack of information necessary to determine the proper size of controlled valve which will permit the instrument actually to maintain the desired control. Flow lines are very often tremendously over-size and will therefore bear no relation whatsoever to the proper size of controlled valve. This error may be entirely eliminated by furnishing the instrument company information as to the conditions under which controlled valves must be operated in order to deliver the desired amount of controlled medium.

Due to the rapidity of changes of temperatures, pressures, resistances, and flows in the process, caused by variation in operating conditions, automatic control, in the manufacture of natural gasoline, is a very different problem from ordinary regulation; and instruments capable of delivering accurate, unvarying control, must involve an entirely different operating principle than is found in ordinary regulators, and be capable of causing the controlled valve to react to a full floating action. By "full floating action", we mean that the controlled valve must open to a certain opening capable of delivering the required amount of controlled medium under the existing natural conditions, maintain this opening as long as conditions remain the same, and vary from it only in direct relation to the changes of condition. A controlled valve should never open beyond the opening necessary to deliver the required amount of medium—or close below this point.

The most desirable factor in the manufacture of a special high grade natural gasoline is the maintenance of a very uniform, close specification, finished product. These specifications are the result of many reactions encountered in the cycle of the process; and in order to fractionate from the raw material the proper proportion of certain hydrocarbons, which go together to make up the finished product, all of these reactions must be uniform. Such uniformity can only be maintained by accurate automatic control of the most important reactions. Without it, it is doubtful whether high pressure stabilization would be at all possible.

THE first important reaction is in a multiple-absorber type of absorption plant in the proper proportioning of the amount of absorbing medium per thousand cubic feet of gas. When each absorber has its separate compressors, these compressors, due to a uniform speed and uniform intake and exhaust pressures, will act as volume controllers and deliver constant volume to each absorber. If absorbers are fed from a common header, volume may be controlled by automatic volume controllers to each absorber.

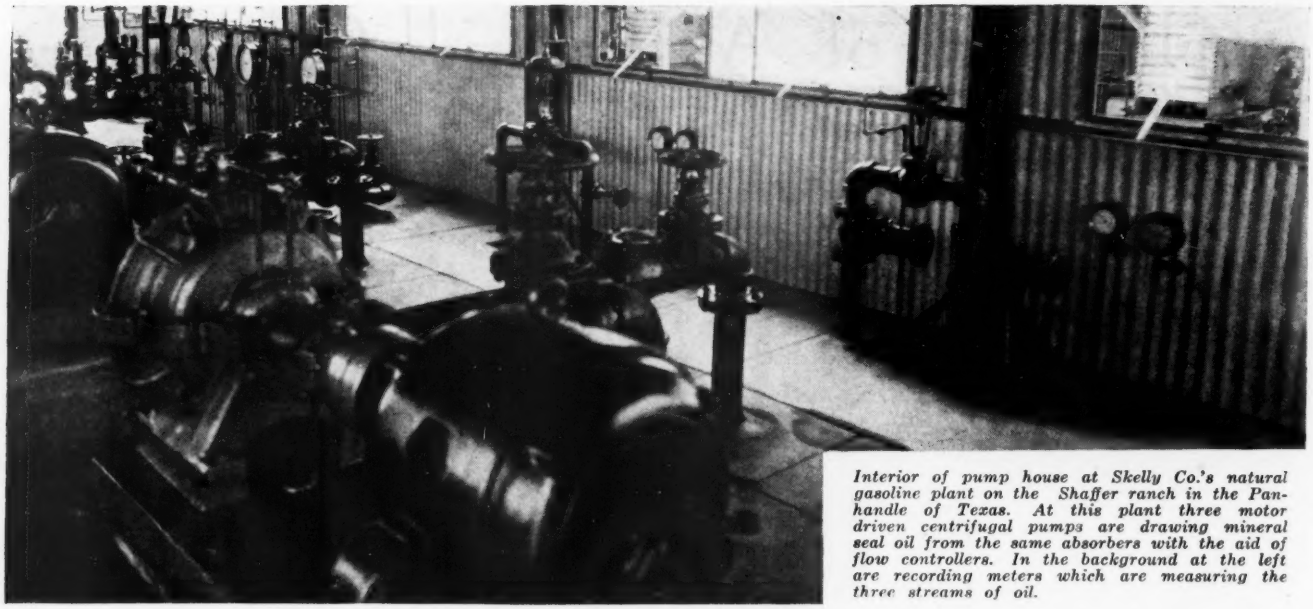
With volume being controlled as a result of either of the above methods, uniform proportioning of absorbent may be obtained by automatic flow controllers controlling the circulation of absorbent oil to each absorber. The quantity control of these two mediums assure the con-

EMBY KAYE

Emby Kaye, general superintendent of the gasoline department of the Skelly Oil Co., has been a gasoline man since he began his active business life, having filled virtually every job connected with the manufacture of natural gasoline. He is not yet 33 years of age.

After his graduation from Harvard with a degree in science, and additional work in the law school, Mr. Kaye was in the air service during the war. From the army he became associated with the Skelly interests in May, 1919, prior to the organization of the Skelly Oil Co.

As operator of a physical test car Mr. Kaye began by testing casinghead gas in the field. Later he was an operator at a Skelly plant on regular tour, a job of which he is proud today. Later he was made engineer in charge of construction work and was superintendent of Skelly's Wynona gasoline plant when the company organized a separate gasoline division on March 15, 1922. Mr. Kaye was made general superintendent in charge of the department when it was organized, the position he holds today.



Interior of pump house at Skelly Co.'s natural gasoline plant on the Shaffer ranch in the Panhandle of Texas. At this plant three motor driven centrifugal pumps are drawing mineral seal oil from the same absorbers with the aid of flow controllers. In the background at the left are recording meters which are measuring the three streams of oil.

tact at all times of the correct amount of absorbing medium with the gas, so that efficient extraction is obtained in each absorber. They permit the still to receive a uniformly saturated oil. A control of the circulation of oil to stills results in uniform flow through heat exchangers, and a uniform flow from the stills results in a uniform exchange of heat units; and, as a result, temperatures and pressures of both inlet and outlet, of both lean and charged oils, are very constant.

In a plant which the writer's company recently installed, it was found absolutely impossible to obtain, without automatic controllers, accurate distribution of gas and oil going to and from five bubble type absorbers and three separate distillation units. The distillation and absorption units were out of balance nearly all the time, and the production varied over 25 per cent. The easy-going "efficiency" in distribution of gas and absorbent in the baffled type of absorber, is absent in the bubble type. It was only after the installation of the flow controllers by representatives of the Foxboro company that efficient control was established, and the maximum production of a uniform product obtained.

THIS brings us to the still or fractionator where the desirable hydrocarbons are separated by accurate control of steam supply to maintain constant temperatures and pressures. The combination of all of the above controls results in the flow of quite uniform hydrocarbon vapors at uniform velocities and under uniform pressures through the final fractionator; and, for these reasons, in order to maintain a surprisingly uniform specification final product, it is only necessary to accurately control the temperature of overhead vapors.

The knock-out or dephlegmator temperature in every gasoline plant today, is controlled by an automatic thermostatic control valve.

Due to the wide variation in designs of natural gasoline plants, it is impossible to say just what processes should be controlled automatically, but a preliminary analysis of the plant will show what reactions are most likely to be affected by changes of power, supply, demand, or atmospheric conditions. But it will be conservative to say that whenever an important part of the process shows a possibility of being affected by some probable variation, the cause of such variation should be counteracted by the application of an automatic control.

Very often the result of a variation tends to exaggerate the original variation and the system is thus continuously out of balance and automatic control is absolutely essential to maintain balance. The reaction of a heat exchanger offers a very nice example of such a condition. We will assume that the flow of cold oil to a heat exchanger has been momentarily reduced. Assuming that the supply of hot oil has remained constant, the result will be that the temperature of the outgoing charged oil has been increased. Thus, an increase in temperature will cause a greater amount of vapors to be generated within the heat exchanger (a condition often described as gas pockets), which will offer a greater resistance to flow—thus building up a back pressure which, in turn, tends to further reduce the flow of incoming charged oil, resulting in a further increase of vapors and thus a further increase of resistance to flow.

This condition could not reverse itself until the flow of incoming hot oil was sufficiently reduced to eliminate the generation of excessive amounts of vapors, permitting less resistance to flow and an increase of the flow of charged oil. With this increase in the flow of charged oil, the outgoing temperature will be reduced, resulting in a decrease of vapors, a decrease of resistance to flow, and an excessive increase in flow. It becomes apparent that the reaction is now unbalanced on the other side and the results of variation always tend to exaggerate the variation; thus, the automatic control of flow, which is, of course, independent of changes of pressure, is the only means that will absolutely insure uniform reactions of heat exchangers.

THERE are types of control apparatuses which simplify operations in a gasoline plant and which enable the manufacturer to operate with a minimum crew without overtaxing it. Today, in an up to date plant, boilers are equipped with level controllers, so that only a given gauge (as desired) may be constantly maintained. Control valves on gas lines furnishing fuel to the boilers, and operated by the pressure in the boiler (as desired), increase or diminish the flow of fuel according to the call for power made upon that boiler. With reasonable occasional observance on the part of the operator, the boiler so equipped will take care of itself. A fire still is similarly "made safe", but, in this case, the temperature of the oil in the still governs the action of the controlled valve.

In recent plants of the writer's company, level controllers have been installed in hot wells receiving the overflow from engine jacket coolers. When a predetermined level is reached, a switch is closed and an electrically operated pump picks up the water and throws it over cooling towers. No longer is there a cause for losing

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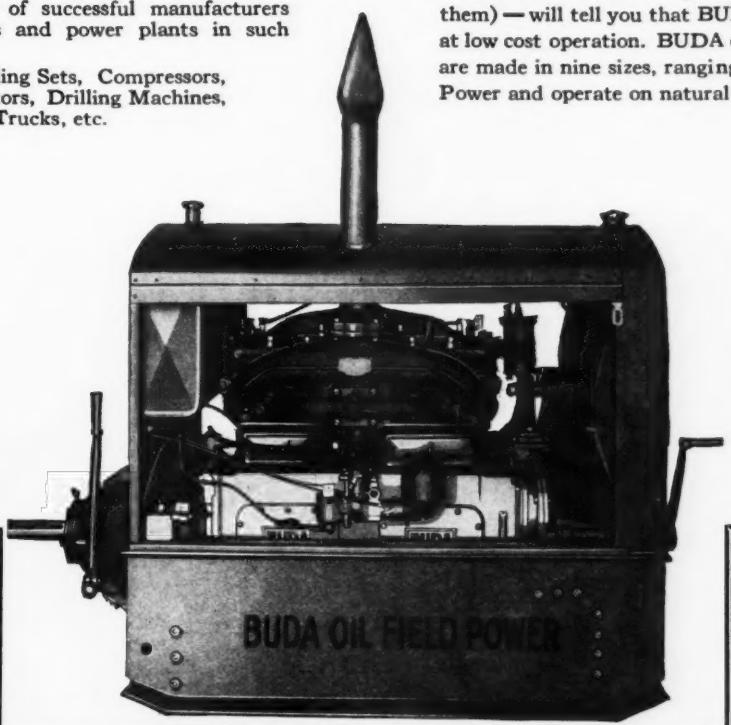

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The hit or miss control of essential reactions in a gasoline plant is no longer the rule. It is strictly "out of tune" with modern development, and economically cannot be justified. It is as reasonable to try to operate a natural gasoline plant without automatic controller as it is to operate an ocean steamship without a compass. Few do. In the writer's judgment, there is no other one thing that has done as much to bring the modern natural gasoline plant to its present high state of efficiency and to so relatively low a labor cost, considering the multifarious processes and reactions, as has the development and adaptation of automatic controllers of the various kinds now on the market.

The scope of this paper will not permit detailed discussion of the advantages of automatic control in connection with all of the reactions involved in the manufacture of gasoline, but the writer is positive that the engineering departments of the various instrument manufacturers are in a position to discuss every reaction in complete detail, and their service divisions are as capable of giving practical form to their discussions.

Waste Heat Utilization in Compressor Plants

By F. L. Kallam

THE purpose of this paper is to point out the causes for the awakened interest in the compression gasoline system during the past year when it was considered in a state of obsolescence. Also, to show that one of the two causes of the awakening, namely the stabilizer, affords a means of utilizing compressor plant waste heat, thereby greatly increasing the economy of such a plant.

During the past six years practically all of the gasoline plants installed in this country have been of the absorption type; a condition resulting from the discovery that the original compression method of extraction was only adequate and commercially efficient when used in handling gases containing upward of 2 gallons of gasoline per 1000 cubic feet of gas. The less volatile, and hence superior product, obtained in the early absorption plants by the simple process of weathering the enriched oil prior to distillation, was perhaps the most convincing argument in favor of the new system.

In this the refineries aided greatly by a prompt expression of preference for the new natural product gasoline over that of the compression plant blends of wild casinghead gasoline and kerosene.

THE demand for a stable natural gasoline on the part of the refiners did not stop with the product obtained from the absorption plant of a few years ago. The necessity for the removal of all so called fixed gases from natural gasoline brought forth and developed numerous methods of gasoline fractionation. Absorption plants in which the product receives its final processing in a stabilizer enjoy the returns on an increased volume of marketable gasoline, together with a product for which there is always a demand and a preference.

The gas-lift system of increasing or maintaining production from oil-wells has recently created a new demand for high pressure circulating gas. This demand was met during the past year by the installation of numerous compression and gas-booster plants of various capacities. While such plants were built primarily for the purpose of well-blowing, it was soon found that considerable gasoline could be extracted from the re-cycled gas; in fact, in some cases the removal of this condensate was imperative to operation during the winter. Thus, by the addition of condensers, accumulators and storage-tanks the gas-lift station became also a compression gasoline plant, and by the same means, the oil producer became a gasoline manufacturer.

The latter is not always the most desirable arrangement. Where facilities are available, it would appear more desirable for the producer to receive high-pressure dry gas from the gasoline manufacturer, who in return would receive the enriched gas for further treating. Such an arrangement should work out to the mutual benefit of the parties involved; the manufacturer could carry on high-pressure absorption with its accompanying higher yields, and the producer would gain materially from the better gas service furnished by large central stations, which service would relieve the producer from investment in the gas pumping equipment.

THERE are times and conditions, however, when such a plan is not feasible, and it becomes necessary to install a compressor station for the delivery of the high pressure gas. As the life of a gas-lift station is somewhat indeterminate, it is advisable to include with the original equipment the apparatus necessary to convert the station into a compression plant rather than install an auxiliary absorption plant.

This is certainly true in cases where the gas contains one and one-half gallons or more of gasoline per 1000 cubic feet of gas, in spite of the relative lower extraction efficiency for the compression system at low gasoline contents.

(*Continued on Page* 222)

F. L. KALLAM

Mr. Kallam is research engineer with the Southwestern Engineering Co., Los Angeles. Graduate of Stanford University in mechanical engineering. He received wide shop experience as special apprentice with Hendy Iron Works, California Iron Works and other companies. Later he was engaged in field work with the Associated Oil Co. and as construction engineer with the Shell Co. of California and the Pan American Petroleum Corp. He has had experience in design, construction and operation also with the California Gasoline Co., Southwest Gasoline Co., Signal Gasoline Co. and Mutual Gasoline Co.

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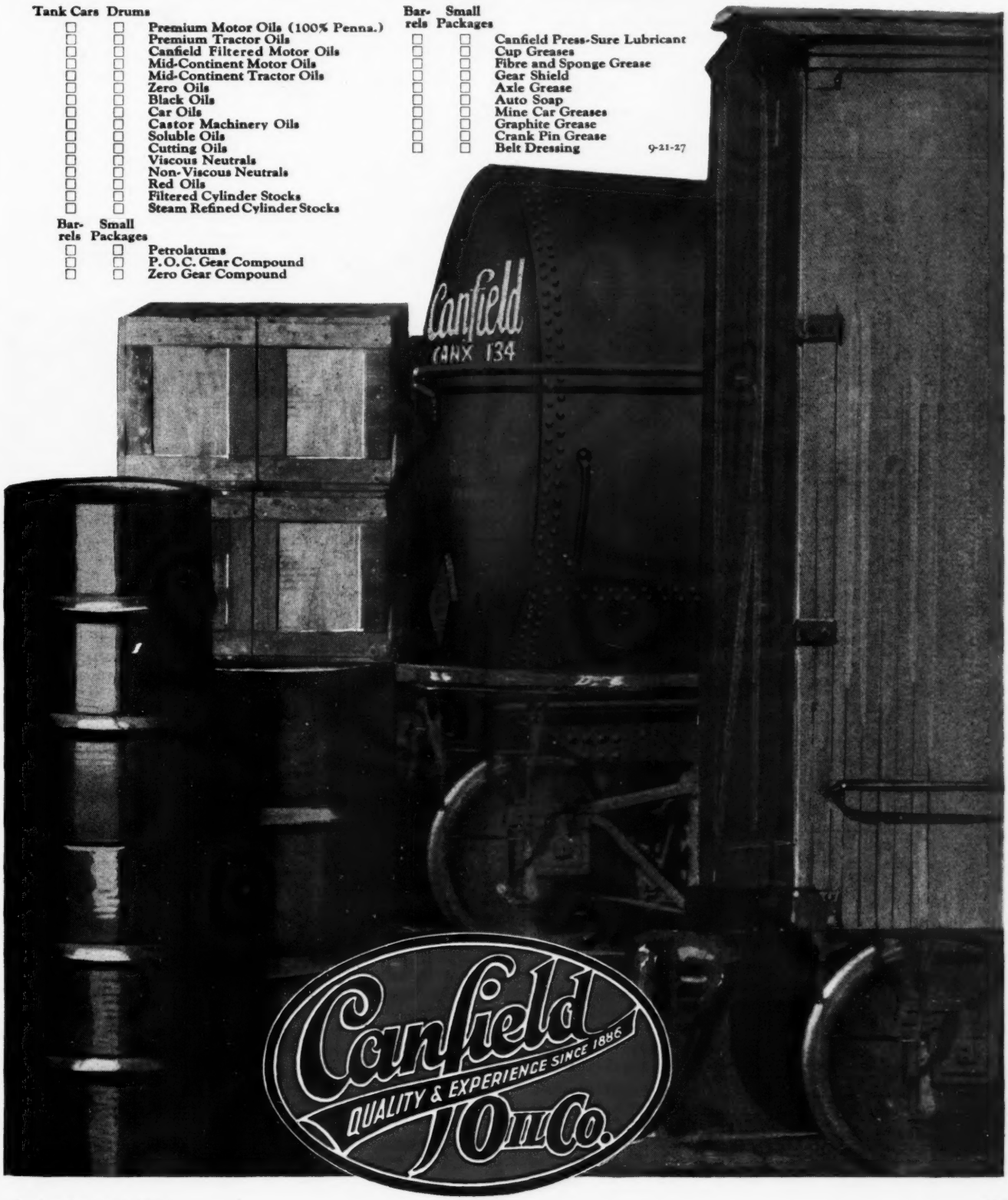

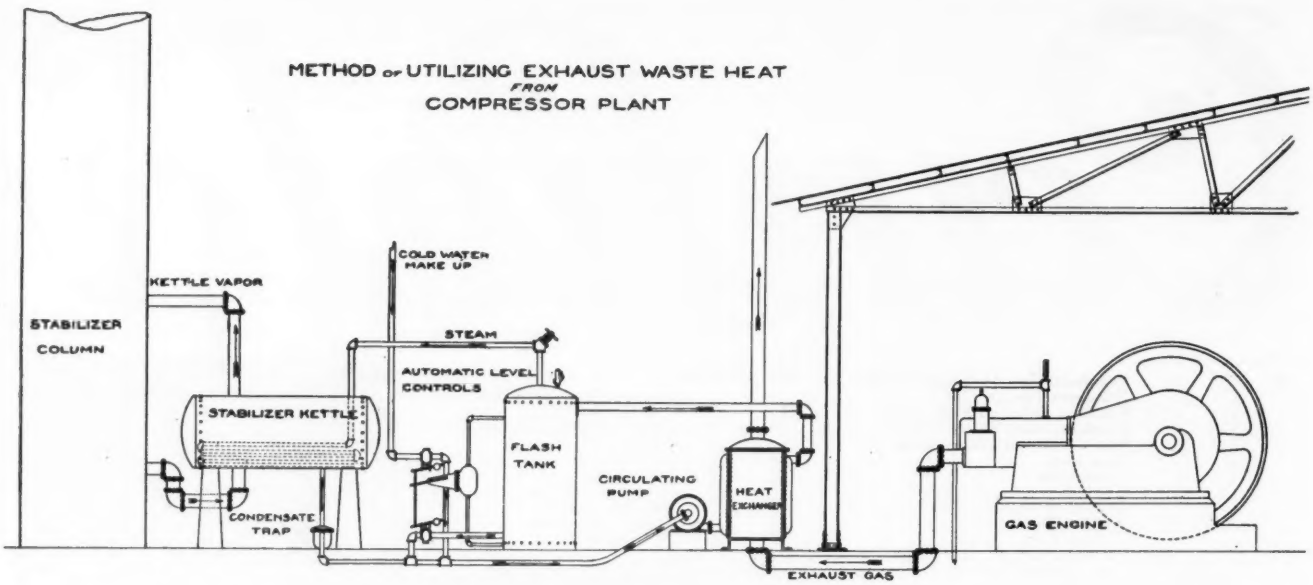

(*Continued from Page* 218)

A stabilizer installed in such a compression plant is no less effective then when used in connection with the oil process—permitting control of the product in exactly the same manner as in the case of the absorption plant. Thus the rejuvenation of the compression system may be attributed to the stabilizer, and to the demand for high-pressure circulating gas.

In the present types of stabilizers, steam is required in the kettle at the base of the fractionator, although the tower temperature gradient may be controlled by the admission of high compression liquid at the top. As practically all compression stations are gas-powered, the requirement for steam in the stabilizer makes necessary the installation of boilers. The steam boiler, being more or less foreign to such stations, as well as a fire hazard, is regarded as a menace. By the employment of certain apparatus and technology, it may be possible to eliminate the conventional boiler plant altogether.

IT IS generally considered that a steam-turbine power-plant, operating with all the modern heat-saving devices is a very efficient plant when a thermal efficiency of 18 per cent is obtained. This performance is equivalent to 14,100 B.t.u.'s per brake-horsepower-hour. With the combustion-engine this efficiency is much increased, for here combustion takes place inside instead of outside the working cylinder. Thus with the gas engine an efficiency of 20 to 28 per cent may be obtained, while in the case of the high compression oil engine the figure increases to 30-34 per cent. This represents approximately 10,000 B.t.u.'s and 7,500 B.t.u.'s per brake-horsepower-hour respectively. In cases where low-pressure steam is used for process work, however, the steam plant can readily reach a thermal efficiency of 40-50 per cent, putting itself beyond competition of either the gas or oil engine.

Considering the average gas engine employed in the gasoline compression plant, probably 25 per cent of the heat value of the fuel is transformed into useful work in pumping and compressing the gas. Another 35 per cent is lost in the heat carried away in the jacket-water, and a nearly equal amount in the exhaust gases.

NOW if these heat losses could be recovered entirely, or in part, and utilized in the plant, considerable economy could be effected; for the engine thermal efficiency would then be in the range of 40-90 per cent. The stabilizer thus provides means for the utilization of the waste heat. A second possibility in the employment of steam generated by the exhaust gases is in producing engine cooling-water make-up; this would be particularly desirable in localities where the water supply is unfit for use in engine jackets.

European countries are far ahead in methods of waste-heat recovery, although in recent years the use of steam boilers for the recovery of the heat in waste gases, as practiced in connection with cement kilns, open-hearth steel furnaces, coke-ovens, etc., has become common in this country. The utilization of engine exhaust gases has not, however, made much advance.

In a number of eastern oil engine installations the warm jacket water has been used for both process work and building heating, while in a few instances, a portion of the jacket-water has been evaporated by the hot exhaust gases and used for process steam. In these latter cases where a steam generator was employed upon the exhaust, the engines were compelled to operate against a back-pressure of from 2 to 3 pounds, with no particularly detrimental results. A natural gas engine should not be expected to operate satisfactorily against any such back pressures, however.

WASTE-HEAT boilers have been known to recover as high as 38 per cent of the heat value of the fuel fed to the primary furnace. Such boilers, handling waste gases at approximately 1200 degrees Fahr., must be so designed that intimate contact is obtained between the gases and the heating surface without excessive draft losses. In practically all cases induced draft has been resorted to, which from a consideration of economy limits the gas velocities to about 4000 feet per minute.

Such velocities, when combined with a properly arranged heating surface, has been found to be quite satisfactory in breaking up the stream-line-flow tendency of the gases, resulting in a high heat transfer rate. Many waste-heat boilers are heavily penalized in net-return, however, by the excessive power required to maintain draft; which energy should not exceed 3-6 per cent of the boiler output.

As with any type of boiler, the surfaces must be kept clean at all times if the maximum economy is to be obtained. This is one of the troublesome problems in connection with ordinary waste-heat boiler installations and means must be provided for the frequent removal of the dust and soot. While trouble of this nature has been experienced in exhaust heaters, using the exhaust from oil engines, it has been more pronounced in connection with engines of the 2-cycle type. Little difficulty should be encountered from this cause when using the exhaust gases from a natural gas engine. Also, the exhaust from such an engine is free from abrasive particles, such as found in cement kiln waste gas, so that precautions are unnecessary to

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prevent cutting or deterioration of the heating surface from this source.

Several European builders have installed boilers of the locomotive type in which the end boxes have been of cast-iron separated by steel tubes. The hot engine-exhaust gases pass through the 2-inch tubes. The jacket water from the engine furnishes the feed-water to the boiler, which is introduced into the latter by means of an injector. Steam is generated at from 100 to 150 pounds gage.

The following is the report of a test made in 1910 on an installation such as described; the engine being a 1500-horsepower double-acting, blast-furnace engine:

H.P. developed (brake)	1290
Area of exhaust heater surface sq. ft.	1620
Heat consumption, B.t.u. per br.h.p.hr.	10080
Steam produced, pounds per hr.	2405
Steam pressure, pounds sq. in.	102
Percentage of waste-heat utilized	30
Temperature of feedwater, deg. Fahr.	104
Temperature gas from engine, deg. Fahr.	842
Temperature gas from heater, deg. Fahr.	518
Boiler H.P. developed	70

The steam generated by this waste-heat equipment was used in a turbo-generator and effected an increase of 13 per cent in total power output of the plant.

A SIMILAR utilization of the waste gas from several engine-generators was reported in this country during 1925. A test of this installation gave the following figures:

Total heat to engines, B.t.u. per hr.	50,524,000
Total heat in exhaust, B.t.u. per hr.	19,000,000
Per cent	38
Temperature of exhaust gas, Deg. Fahr	1000
Heat convertible in waste-heat boilers, B.t.u. per hr.	9,500,000
Boiler H.P. available per hr.	279.4
Exhaust heat from engines utilized, per cent	6.5
Total steam generated, B. H. P. hr. per month	57,000
hr. per engine hr.	19

As can be seen from the above table, only one-sixth of the heat in the exhaust gas was utilized at the time of the test. This was later increased considerably by the installation of greater boiler capacity; the boiler surface being merely coils of tubing placed in the exhaust manifold. Water from the engine jackets at 145 degrees was used for feed-water.

These two brief tests are presented to help show that the recovery of waste heat from large gas and oil-engines has been practiced commercially for a number of years, and that it has proved to be practically free from mechanical trouble as well as being very economical. With engines of the type referred to it is safe to assume that between 1.5 and 2.5 pounds of steam can be generated per hour for each brake-horsepower developed. In practice this steam has been generated at pressure ranging from 65 to 170 pounds gage.

Turning now to the natural-gas-engine as used in compressor-plant practice it may prove interesting to consider their waste-heat recovery possibilities. A typical 160-horse-power duplex gas-engine running at 200 r.p.m. was exhausted through a Southwestern heat-exchanger, containing 144 square feet of heating surface. Water from the engine jackets was circulated in three passes through the ¾-inch tubes counter-current to the outgoing exhaust gases. A test of this unit follows:

Heating valve of gas, B.t.u. per cu. ft	880
Gas consumed by engine, cu. ft per hr.	1820
Volume of exhaust gases, cu. ft. per hr.	65000
Velocity of exhaust gases to Exchanger, Ft. per sec.	1320
Velocity of exhaust gases from exchanger, Ft. per sec.	885
Pressure of exhaust gases at engine, in. hg.	0.75
Temperature gas to exchanger, deg. Fahr.	1080
Temperature gas from exchanger, deg. Fahr.	174
Water circulated, G. P. hr.	1242
Water velocity through exchanger, ft. per sec.	0.43
Temperature water to engine, deg. Fahr.	64
Temperature water from engine to exchanger, Deg. Fahr.	117
Temperature water from exchanger, deg. Fahr.	164
Heat Balance:	
Total heat to engine, B.t.u. per hr.	1,601,600
Heat converted to power, per cent	25.5
Heat in jacket water, per cent.	34.3
Heat recovered by exchanger, per cent	30.4
Radiation & unaccounted for, per cent	9.8
B.t.u. required by engine per B.H.P. hr.	10,010
Heat transfer in exchanger, B.T.U. sq. ft M.T.D. hr.	10.9

ASSUMING that the water from the exchanger at 164 degrees can be used to advantage, the thermal efficiency of the combined engine and exchanger is 90.2 per cent. Or in other words, the use of this exchanger made it possible to recover 75.7 per cent of the heat lost in the escaping exhaust gases.

The heat transfer obtained with this exchanger under conditions of the test was exceedingly high, being of the order of 10 B.t.u. per square foot per hour per degree mean temperature difference. This is considerably above the usual transfer rates given in literature, and the water velocity was under ½ foot a second, which is much less than general practice.

The arrangement of the heating surface, besides being new and clean, was such that the gas was forced into maximum turbulence, or tumbling stage, thereby reducing to a minimum the thickness of the insulating gas film on the outside of the tubes.

Despite this very turbulent gas flow through the heater, the pressure-drop was of small magnitude, resulting in a back-pressure at the engine of less than 1 inches of mercury. The gas flowing across the tubes resulted in numerous changes of flow direction which, coupled with the gradual diminution of gas volume, caused a muffling action that reduced noise to a minimum.

HAD this engine been arranged for steam generation, and the 75 per cent of the total heat in the exhaust, or 487,000 B.t.u.'s per hour, utilized for this purpose, there would have been available 487,000/33,479 or 14.5 boiler horsepower. Assume now that in the average compressor-plant the stabilizer requires steam at 50 to 100 pounds gage, and in the proportion of 0.25 pounds to 1 gallon of raw gasoline treated.

Applying the 14.5 b.h.p. available from a 160 h.p. gas engine it would be possible to treat (14.5 x 34.5) (.907) /0.25 or 1814 gallons. This figure is based upon the engine running at full-load. At less than full-load the fuel rate of the engine is increased and the heat recovery rate increased; that is, there would be more heat available per engine horsepower.

While there are a number of factors to be considered in the successful utilization of gas engine waste heat, one of the most important is the engine load. If this is constant, the exhaust temperature will also be constant, giving a constant mean-temperature-difference between the water to be evaporated and the hot gases. If the load is variable, however, the mean-temperature difference will vary, and at times will be smaller than at others. Under such conditions it will be necessary to select the steam-pressure for the lowest temperature-difference and design the heating surface accordingly.

Although the principal purpose of this article is to call attention to certain heat losses in compression and gas-booster stations, it may be interesting to present briefly a possible recovery method. The problem in the gasoline industry is rendered somewhat difficult by the small-

sized power units in service. This results in a large number of units in any one plant. In event that a heater, or boiler, is applied to each engine, considerable manifolding is eliminated. European practice is to use one central recovery unit employing manifolds to each power unit. Probably each method has some merit.

The illustration shows a scheme, using the unit system, for producing steam for a stabilizer. This plan does not consider the use of jacket water, because of the large amount of piping required to make the change-over in an existing installation.

The make-up water for the system would enter the separator tank, the level in which would be controlled by a conventional level control valve. This valve would also control the outlet from the tank into the pump suction. The pump, which may be a centrifugal, would handle the feed water to all the units, the distribution to each being governed by the aid of meters or other means.

THE steam generating unit for each engine would contain the amount of heating surface necessary for the conditions of operation. These generators would be so designated that both inside and outside of the tubes would be accessible for cleaning. Feed water would be pumped through these heaters or generators into the separator-tank. Starting this system with cold water would require some little time before pressure could be built up in the lines, but eventually steam would accumulate in the separator or flash tank.

When steam pressure is raised to the desired point the automatic check on the separator tank opens and allows steam to pass to the heating coil in the stabilizer kettle. Here the steam gives up its heat to the gasoline, and after condensing, passes through the usual condensate trap.

Assuming that steam is generated at 90 pounds gage, the temperature of this condensate might possibly be 328 degrees. By allowing this condensate trap to discharge into the pump suction, the temperature of the feedwater is very materially raised, being only a few degrees lower, than the temperature of saturation. By proper design it would undoubtedly be possible to dispense with the condensate-trap. Such a recovery system should operate with a minimum of maintenance and at the same time, show an excellent economy.

The writer desires to take this opportunity to publicly thank Mr. C. O. Sandstrom of the Southwestern Engineering Corp. for his able assistance in preparing this article.

Transportation Chief Difficulty In South American Operations

By J. Edgar Pew*

THERE are many handicaps in connection with carrying on oil operations in foreign countries, all of which must be solved before these are made to succeed.

First there is the question of supplies and equipment. In the same work done in the States, materials and equipment of all kinds, and to meet the requirements of each particular operation, are generally available or can be easily obtained without loss of time.

In foreign operation the needs of equipment and supplies must be foreseen and much larger stocks carried by the operators. This is especially true in Venezuela and some other South American countries, both because of the great distance from supply centers and for the fact that the concession rights acquired by the operators permit them to bring in, free of duty, all equipment and supplies.

The supply companies, not being able to use these exemptions cannot carry in that country their usual warehouse stock which they would otherwise do.

COMPANIES operating in Venezuela and other South American countries also usually have to provide their own machine shops as there are no shops doing a general business for the public and with equipment for oil field work.

Second: transportation in South America is also done largely by the operating companies. This applies to materials and to oil. In Venezuela the oil fields are around Lake Maracaibo and transportation of material via water is had either directly to the scene of operations or to within a few miles of the same. Motor boats, operated by gasoline engines, and larger boats driven by oil engines of the Diesel type, afford the means of transportation both of employees and of materal. Airplanes and hydroplanes will probably be used in the near future for quick travel in these operations.

Oil produced in the Maracaibo Basin is transported in shallow draft tankers to deep water loading ports. These draw not to exceed 12 feet of water and carry from 12,000 to 20,000 barrels.

Access to interior operation located back from the lake from one to 50 miles is a more difficult proposition. This has been solved in the case of developed properties by the construction of narrow-gauge railroads as at Mene Grande and El Mene.

In wildcat wells the transportation from the lake to the location is frequently one of the greatest items of expense, and is done by the use of truck, or in more unfavorable areas by tractors. Much of the territory to be covered is through a jungle country and on account of the large amount of rainfall and the thick vegetation, roads are generally in a terrible condition. Rains are of daily occurrence for 9 and sometimes even 12 months of the year in this jungle territory.

POWER for field operation is had by the use of both oil and gas. A project for the electrifying of the fields along the east side of Lake Maracaibo was being considered in March of this year, and this will probably be available within the next few months if it has not already been completed. This will take care of the operations in La Rosa, La Benita and Laguinillas.

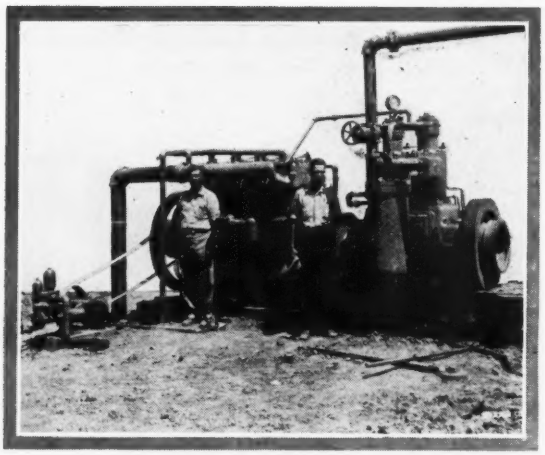
Communications between the field work and offices of the companies is very inadequate and unsatisfactory. There is practically no public telephone systems, and telegraphing is slow and unsatisfactory. Wireless telephonic communication would be ideal and this will be resorted to as soon as permitted by the Government.

The rotary system of drilling is used almost exclusively in Venezuela, and drilling conditions encountered do not differ greatly from those in parts of south Texas and Louisiana. The same equipment is used and excepting for the handicaps incident to any foreign work results are very much the same. Native, American and English labor is used. The skilled labor is almost wholly from the States and England.

Health conditions are those incident to any tropical operation, but good medical staffs and hospital facilities, practically all of which are supplied by the operators, are overcoming these natural handicaps. Other than the problems of supplies, transportation, communications, and those suggested by the general tropical conditions, all of which create their handicaps mostly against the speed of operations, there are no conditions or engineering difficulties that might not be encountered elsewhere. The methods of operation are similar and the skilled labor used is transferred mostly from the States.

*Vice President, Sun Oil Co.

SEVEN CLARK VER T
in a single Mid-Continent I



The Tidal-Osage Oil Company installed 7 Clark vertical compressors in their Shidler, Oklahoma, booster station for a unique purpose. When the wet gas, which they sell to another Mid Continent manufacturer, has been denuded of its gasoline content, the dry gas is returned to the Tidal booster station pictured opposite and is pumped back 9 miles into old wells, where it is stored for future use.

The Clark vertical is *quickly set up* at the well location, a *Big* advantage in properly applying air and gas to flowing wells, as authorities on this method emphasize the importance of putting on pressure while the well is sufficiently headed. The vertical is ruggedly built, and therefore dependable for continuous operation over a long period. The engine driving the compressor is the same as required for foundations. See this new compressor, as well as other recent Clark developments, at the Petroleum Exposition, where they will be shown on lot A. Clark Bros. Co., Olean, N. Y. Mid-Continent branch and warehouse at 125 W. First St., Tulsa, Okla. Other warehouses at McCamey and Sweetwater, Texas and Artesia, N. M. Also Smith, Booth, Usher Company, 228 S. Central Ave., Los Angeles and 50 Fremont St., San Francisco.

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DRILLING ENGINES
PUMPING ENGINES

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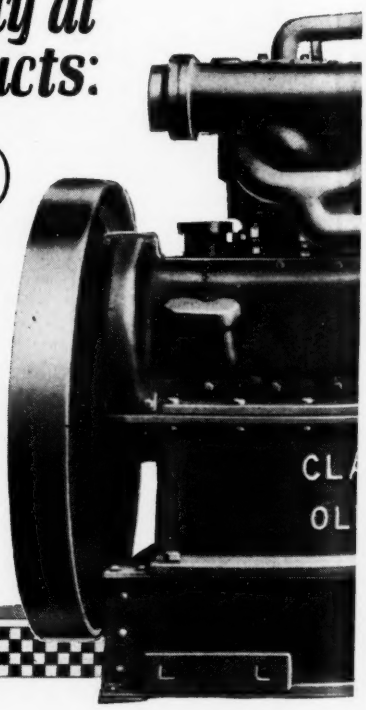
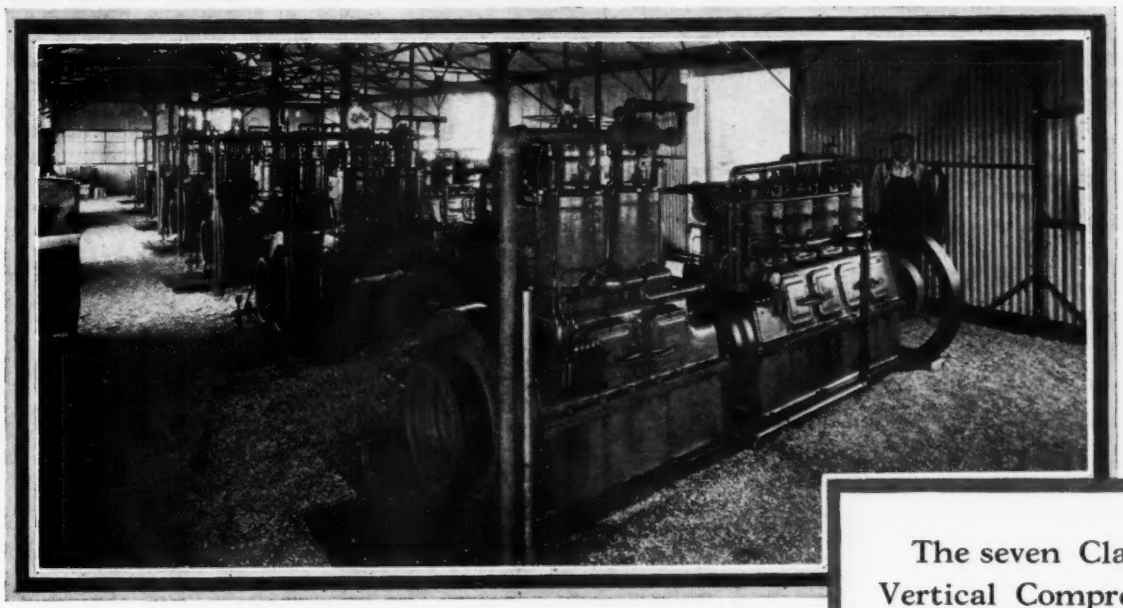


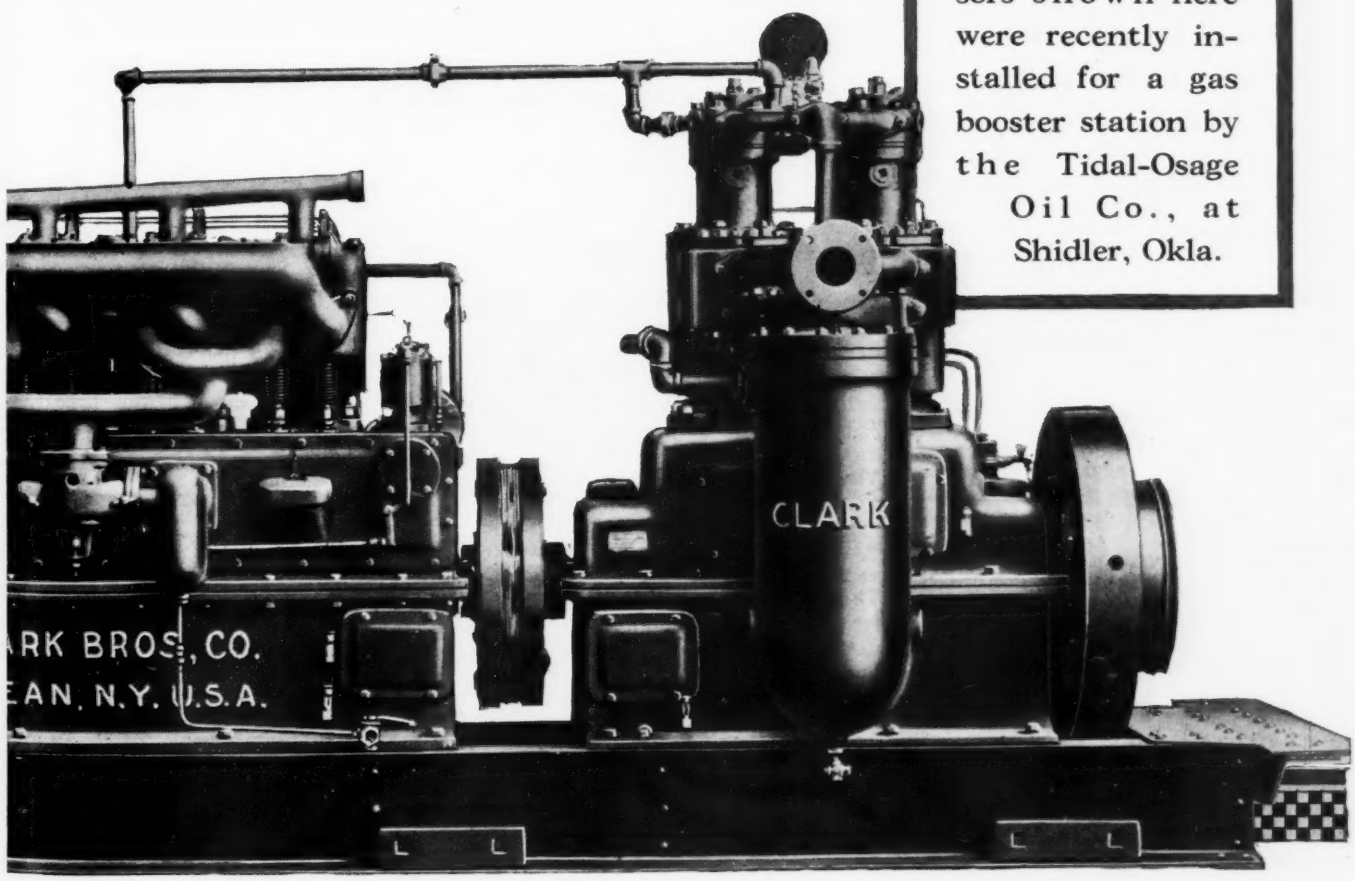
Clark Bros. Co. OLEAN N.Y.

TICAL COMPRESSORS

Installation



The seven Clark Vertical Compressors shown here were recently installed for a gas booster station by the Tidal-Osage Oil Co., at Shidler, Okla.



Cooling in Natural Gasoline Plants

By F. A. Earle Lowell

IN OUR natural gasoline industry the cooling problem is of primary importance. Of all the gasoline extraction and gas compression plants, each one has to meet the cooling problem. If it is possible for us to improve any of the efficiencies involved in the cooling problem, then it is possible to decrease cooling installation costs and thereby decrease our plant costs.

As an illustration of how plant costs can be effectively lowered, it may be said that the average cost of a gasoline plant five years ago was about $10 per gallon of rated capacity, whereas now, we are able to complete a plant for similar service for $5 per gallon of rated capacity. With such a saving in cost, and other things being equal, the plant will now pay out in half the time that was formerly required. The difference in the two costs is now being turned into net earnings, or profit. Due to improved methods or greater efficiency developed in the older methods, it is believed that plant cost will continue to be on the decline.

In the average plant the investment in cooling equipment amounts to about 20 per cent of the total plant cost. Of equal importance to reduced installation costs is the difference in production which may be attributed to the better resultant cooling of an adequate cooling system, as compared with another cooling system which is not so good.

The gain in production which we are entitled to receive whenever we have the proper cooling system, is again reactive on the plant net earnings, or profits, and the better cooling system will earn the greater profit.

To summarize the whole cooling situation briefly:

1—We must have an adequate cooling system to assure us of the maximum production.

2—We should endeavor to design our cooling system so that it will perform so as to give us the maximum production with the least installation and operation cost.

COOLING by refrigeration is rather expensive, and its use in connection with gasoline plants is rather limited. Another method of cooling, which is excellent, is the use of natural cold water, such as river, or ocean water. Unfortunately, we cannot all be located near such sources of cold water, and if we were so situated, we would probably have to contend more or less with severe corrosion and scale. Another method of cooling which is also out of the question, except in extremely cold climates, is the placing of cooling coils in the air and, without circulating water over them, securing a transfer of sensible heat from the coils to the air.

F. A. EARLE LOWELL

Mr. Lowell was graduated from the United States Naval Academy at Annapolis, class of 1921 *and served as mechanical engineer in the producing department of the Standard Oil Co. of California until* 1924. *At present he is superintendent of operation in the gas department of the Pan American Western Petroleum Co. with headquarters at Los Angeles. He takes an active interest in the affairs of the California Natural Gasoline Association.*

The only practical way to obtain our cooling is to cool water by exposing it to the air, and then to use this cold water for cooling whatever else we may desire.

The first problem for us to consider is the cooling of water. There are a number of different ways of accomplishing this end, namely, by spray pond, spray tower, deck tower, and the forced draft tower. The two most recognized methods of cooling water are probably the spray tower and the deck tower methods. There are several good makes of deck towers on the market, so that we know a great deal about the performance of such towers. The definite performance of spray towers is not so well known, but it is believed that a very efficient tower of this type can be built.

As already stated, the first problem is the cooling of the water. It is necessary to choose the water temperatures to and from the tower as well as the quantity of water over the tower. It is possible to vary the concentration of water in different parts of the tower and thereby obtain final water temperatures over quite an extensive range. In other words, we may circulate 100 gallons per minute of water over the top of a tower at 90 degrees Fahr. temperature. It is cooled to 70 degrees Fahr. by the time it reaches the basin.

NOW, if we circulate a quantity of 150 gallons per minute of 90 degrees Fahr. temperature water over the same tower, the final temperature will be 75 degrees Fahr. We have, of course, assumed the humidity, wet bulb, and wind velocity, to be the same in both cases. In the second case we dissipated 12½ per cent more heat, although the final water temperature was not as low as in the first case.

From a survey of actual operating conditions in the field, the extremely advantageous results to be secured by controlling the distribution of water circulation is, apparently, not very well understood. It may be seen from the above example, however, that whenever we wish to obtain the lowest possible temperature it will be advisable to decrease the rate of water circulation, but whenever we wish to lose as many heat units as possible, it will be beneficial to increase the rate of water circulation.

Many plants use the closed type of tubular heat exchanger—circulating raw spray water through the tubes. Other plants use pipe coils or small diameter tubular elements actually placed in the cooling tower, upon which elements the spray water falls. The latter type of coolers are commonly known at atmospheric coolers. The shell types of tubular heat exchangers are excellent whenever the medium to be cooled is non-corrosive or non-scaling, but they are not generally satisfactory for use with the average circulating spray water.

The atmospheric coolers will, very probably, eventually prove to be the more satisfactory for cooling service. To obtain the best possible results from atmospheric coolers, more careful observation and operation will be required than is necessary with the closed type of cooler. In the case of the closed cooler, there is generally

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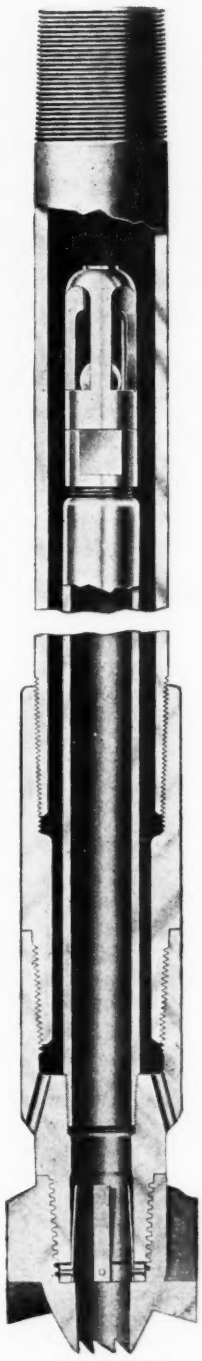

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Sub. (From drill size to pipe size.)

no way to improve the cooling results as we have very little control over its performance after it has been installed.

In most gasoline and gas compression plants we are generally confronted with two cooling problems. If we were situated so that we could economically build and operate two cooling towers—one to fulfill the requirements of each problem—then we would have very closely attained the ideal.

AS A PART of our gasoline extraction process we are frequently desirous of cooling absorption oil, gasoline, gasoline vapor, or gas to the lowest economical temperature. As a general rule we do not have such large quantities of heat to dissipate in this type of cooling—we are rather confronted with the task of temperature reduction. In order to secure the maximum temperature reduction, of course, we must take away the maximum amount of heat. In most atmospheric cooler designs we usually determine the allowable pressure drop within the cooler tubes; from this determination we arrive at the heat transfer coefficient.

Having once determined the amount of heat transfer surface and the heat transfer coefficient, the only remaining way for us to cool the fluid within the cooler tubes to a lower temperature is to provide colder water on the outside of the tubes, and in this way increase the mean temperature difference. If we can increase this mean temperature difference, then we will dissipate a greater quantity of heat and attain lower temperature.

It is now in order to suggest how we can have colder water striking our coils. The answer is to control the rate of spray water circulation, and maintain the correct circulation rate. It is assumed that we are cooling fluids of which the specific heats are approximately .5, while the specific heat of the spray water is 1.0. This means that we do not have to circulate as much spray water as would be necessary if the specific heat of the fluid inside the tubes were more than .5.

Now, if we maintain a spray water circulation rate so that the water will be cooled to as near the wet bulb temperature as possible, and so that the temperature of the water leaving the coils is not excessively high, we shall no doubt find that there is a definite spray water circulation rate which will give us the greatest mean temperature difference, and the lowest temperature—the goal for which we are striving.

IF WE increase or decrease the spray water circulation rate from the one circulation rate which we find to give the lowest final temperature, then, of course, we shall not be enjoying the best performance of our apparatus. It is difficult to say definitely what the correct rate of spray water circulation should generally be.

The various cooling towers have various efficiencies, and the prevailing climates of different localities are so different in respect to windage and humidity. The problem of finding the correct rate of circulation, however, is not difficult in any one case. In practice to-day we shall find, upon investigation, that spray circulation rates vary from .25 of a pound to 25 pounds of water per square foot per minute. This is quite an extensive range. So much for the type of cooling where temperature reduction is of primary importance, and the total heat dissipated is only of indirect secondary consideration.

As another type of cooling in gasoline plant practice, we often wish to cool quantities of water, or condense steam. In this case we do not especially care what the final cooled temperature happens to be, so long as it is within reasonable limits. We are chiefly concerned with the disposal of as many heat units as possible. The specific heat of the fluid which we are cooling within the tubes is identical with the spray water which we are circulating over the tubes.

QUITE naturally, therefore, a greater rate of spray water circulation will be required in order to maintain the maximum mean temperature difference. As an example of this type of cooling we may present the task of cooling pure water which is used for cooling gas engine jackets. This water is usually cooled in atmospheric coolers, and the temperature range is generally 120 or 130 degrees Fahr. to 100 degrees Fahr.

It will be noted that the final cooled temperature is not as low as in the first type of cooling, but inasmuch as the total amount of heat removed is greater, and the specific heat is greater than that of gas or oil, it is necessary to circulate a much greater quantity of spray water in order to get the maximum benefit from our cooling installation. As an illustration of this fact, we recently doubled the rate of spray circulation over one of our cooling towers and the final temperature of the engine jacket water dropped from 130 to 115 degrees Fahr.

This result indicates that those same coils were capable of dissipating many more heat units if we provided adequate spray water circulation.

Considering these two types of cooling taking place in the same tower, which is generally the case, we shall probably find that about 65 per cent of the heat to be dissipated comes from the engine jacket cooling water. The remaining 35 per cent of the heat to be lost comes from the gas, oil, or gasoline vapor. In conclusion, it would be ideal to put these two different types of cooling into two separate towers with different basin water temperatures and different rates of spray water circulation; but, in case we are prohibited from constructing two separate towers, then it will still be well worth while to arrange the rates of spray water circulation in the various parts of the tower to our advantage.

"Point Breeze" Goes to Europe

Philadelphia—Aug. 29 marked the beginning of the maiden voyage of the "Point Breeze", recent acquisition of the Atlantic Refining Co.

The boat is a 7,000-ton Diesel electric tanker purchased from the U. S. Shipping Board and reconditioned at the Atlantic's Point Breeze plant under the supervision of L. M. Goldsmith, technical engineer of the company. It is on its way to Europe. Two other boats, the "Sharon" and the "Bessmer" were also purchased from the shipping board and are now being converted into tankers.

Develops Grease Extractor

CLEVELAND, Sept. 17.—The importance of cleaning out all old grease from the gear case of an automobile before new grease is added, has prompted the Warren Refining & Chemical Co., with headquarters here, to develop a device for this purpose. It is called the Warren Electric Grease Extractor, is light weight, easily and speedily operated.

The company claims that the grease extractor will remove all dirty, worn out grease in the transmission and differential at the rate of two pounds per minute. The device weighs five pounds and is simple in construction. It is operated by a worm in the nozzle.

The Warren company has been manufacturing gear and chassis lubricants since 1915. E. L. Cannon is president.

Lewis-Shepard Opens Wisconsin Branch

BOSTON—A branch factory at West Bend, Wis., has been recently established by Lewis-Shepard Co., with headquarters here, for the manufacture of its four-way arc-welded steel frame platforms to furnish quicked and more economical service to its western territory customers.

All steel platforms are arc-welded to provide a rigid, one-piece frame equal to the full strength of the steel. This was done after two and one-half years of experimental work in completing the company's present design, which does away with the old type or bolted or nailed designs.

OIL CITY, Pa.—A recent business visitor at the Oil City plant of Joseph Reid Gas Engine Co. was O. C. Staples, manager of the machinery department of Frick Reid Supply Co., Tulsa.

The Evolution of the Oil and Gas Separator

By Alexander B. Morris*

THE present widespread use of the oil and gas separator and its application to all sorts of operating conditions is such a common-place fact that the operator is in danger of losing sight of the slow and arduous course of development through which this piece of equipment has passed to reach its present state of perfection.

Separators, or gas traps as they were previously called, have been built in many forms, but all embody the same basic idea; though the method of application is varied in each of the several types. This basic idea is to arrest the speed of flow in a chamber so that the gas and oil have time to separate, and to take off the gas from the top of the device and the oil from the bottom.

A minute's consideration will show that there are three principal sets of conditions under which gas and oil are produced from a well:

1. The volume of free oil, though considerable, may be very small in comparison to the flowing volume of the gas, which in this case will carry the oil as a spray or in small splashes.

2. The volume of gas may be small in comparison with the oil, in which case the gas appears as bubbles within the oil body.

3. The oil may be driven from the well in "heads" containing little free gas, but followed up by large flows of gas containing but little oil.

It will also be seen that the dividing line between these classes is very difficult to set, and the class in which any particular well will flow frequently depends upon the type of equipment provided to receive its production. Thus, if a well is flowing steadily under high pressure, the gas will be in the form of bubbles; but if the pressure is suddenly decreased, the expansion of these bubbles may result in a spray issued from the discharge line. Again, if a well is spraying, and pressure is applied, the velocity of the stream may be reduced to such a point that a large part of the separation takes place in the casing, the oil collecting in slugs in the pipe and being discharged in "heads" followed by flows of gas carrying only some spray.

THE earliest type of separator was the open flow tank into which the entire production of the well was discharged. In all the early types of separators, the emphasis was altogether upon the oil. Conservation of the gas was a secondary consideration, and in many cases the use of a separator was dictated solely by the necessity of getting rid of the gas in the easiest way possible. In recent years, however, it has been necessary to design and use separators that permitted of receiving and delivering the gas at usable pressures as well as rendering the oil gas-free.

According to W. R. Hamilton (Bureau of Mines Technical Paper 209) one of the earliest gas traps on record was used in Oil Creek, Pa., about 1865. A barrel was set upon the top of a tank. The oil and gas entered the top of the barrel through one bung and the gas escaped through another at the top. The oil flowed out the bottom through a U-tube, which provided an oil seal and prevented the escape of gas. This early trap, though primitive, embodies the basic principle of gas trap construction. Other traps are modifications to provide for special conditions.

MANY such traps are in use today, in the older depleted fields of the country, and where the recovery of the gas is not important for one reason or another.

Another early type of trap familiar to all old operators is made of a piece of large casing set vertically in the tank, the intake line from the well being led well down into the pipe from the top, through one hole of a two-hole cap. Separation takes place in the casing, the oil in the tank providing the oil seal, the gas being led away through the other opening in the cap. A variation of this same idea is found in the 60-foot vertical casing trap sometimes set up along side the derricks of flowing wells. In this form, the oil seal is provided by a goose neck of 2-inch pipe leading from the bottom of the casing upward about 30 feet. The back pressure that such a trap will permit is, of course, measured by the height to which this goose neck rises. Gas, as in the tank type, is removed through another opening in the top of the casing.

All these traps are adaptable only to wells of relatively small flow and low pressure. They were originally constructed from material already at hand; but they are not suitable for wells of large oil production, or delivering oil-free gas at high pressure. It is in such service that the modern gas traps—now known as oil and gas separators are chiefly employed; and in which they have proved themselves an indispensable adjunct to production.

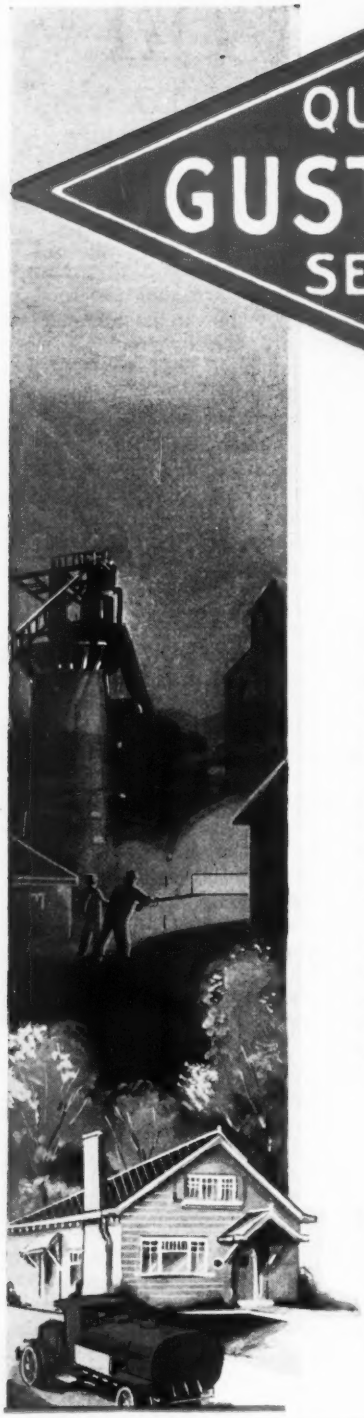
It has been repeatedly stated in advertising and in literature on the subject, that an oil and gas separator is merely a modern highly-specialized form of flow tank; and this point should be borne in mind in considering all such devices.

IN THE early days of the industry each operator had to construct his own apparatus with materials at hand because until recent years it was imposssible to buy separators already fabricated. The special construction of elaborate equipment is very costly and hence the idea was formed—quite properly at the time—that the cheapest trap was the home-made affair built up of material carried in stock by the supply companies or found in the lease warehouse. Today, however, the use of shop fabricated separators has so greatly increased that they can be put out by the companies specializing in them at less cost than similar equipment can be purchased and fabricated on the job.

With increasing markets for gas, it became necessary to provide separators that would (1) deliver the gas at pipe line pressures or (2) permit carrying a vacuum on the well. Both these conditions, signifying pressures widely differing from atmospheric pressure, required the use of some sort of discharge valve controlled by the level of the liquid in the tanks, and a tank strong enough to withstand the pressure differences demanded. Many forms of liquid level control have been employed for this purpose. In one trap, the entire apparatus was hung from one end of a walking beam, from the other end of which hung a counterbalance weight a little heavier than the empty trap. As oil accumulated in the trap it became heavier than the counterbalance weight, thus causing the trap to fall itself and raise the weight. The movement of the tank operated a valve through which oil was discharged until the weight of the trap was insufficient to overcome the counterbalance. The trap was then raised by the counterbalance and the valve closed.

Another old form consisted of a small tank outside the large one and attached to a valve stem on the oil discharge line. This small tank was

*Chestnut & Smith Corp.



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on one end of an arm, on the other end of which was a counterbalance weight. Gas pressure was equalized in the two tanks by a pipe on a swinging joint. As the liquid level in the two tanks rose, the small outside tank became heavier than its counterbalance, actuated the valve and caused oil to be discharged until the level had fallen to such a point that the weight raised the small tank again, closing the valve.

THE oil and gas separator of today is, therefore, the result of years of development, embodying the trial and abandonment of many methods and devices calculated to aid one or another of the main aims—recovery of oil or gas, or both. Throughout, the basic idea has been the same; provision of a large chamber for separation, and two outlets, one for oil and one for gas. The size and strength of the tank has steadily increased, and the control on the oil outlet has been steadily improved. Various systems of baffles have been introduced to aid in the process of separation, and theories have been put forward in support of each system. For the most part these theories are conjectures unsupported by actual observation; so that the real test of effectiveness is in actual application of the entire device to operating conditions.

The most successful oil and gas separator on the market today is one capable of handling wells under a wide range of conditions. The separator at times is expected to operate under excessive well pressures and to maximum capacity, at other times at atmospheric pressure or vacuum and on pumping wells. It has been the aim of the separator people to construct and offer to the oil and gas industry a type for every service and a size for every production need. It is with this thought in mind that each individual type is constructed so as to give the producer the greatest amount of service for the actual money invested. In fact, performances of oil and gas separators in our recent fields, such as Cromwell, Seminole, Mehan and Garber, west Texas and others, prove conclusively to the progressive producer that the money invested in oil and gas separators pays him a greater dividend than any other type of equipment on his lease. There is practically no mechanism on the separator to wear and the length of its service is indefinite at no operation expense.

The best of material and workmanship are placed in the construction of the oil and gas separators and, on account of their being made in volume lots, the sales price to the producer is kept down to the minimum. An installation can be cited where one individual separator has handled a total of 28,000 barrels of oil and

over 100,000,000 cubic feet of gas within 24 hours. Separators from this capacity down to the small separator provided for the pumping well are standard types and can be delivered on the lease with reasonable promptness.

Oil and gas separators have proved themselves of especial value in connection with wells operated by the gas lift. The necessity of providing some sort of gas tight reservoir for receiving the output of the wells flowed by this means, and the requirement that such a reservoir be rigid and strong enough to withstand high pressures, suddenly applied, turned the attention of the operators to the oil and gas separator as the piece of equipment most likely to meet their needs. That this judgment was warranted, is amply evidenced by the extensive use of separators in all gas or air lift fields. In this service they are subjected as part of their daily performance to frequent and severe applications of pressure, as in "rocking," often greatly in excess of their rated load.

In addition to the separation of oil and gas, a separator has now been perfected for use on wells making water, oil and gas and it will efficiently separate the three, enabling the operator to turn his well into the separator and his good oil into the stock tanks. It must not be understood that this separator will handle emulsions but in many cases oil and water will quickly settle out and without the use of this particular type of separator it is necessary for the producer to have considerable expenditure invested in settling tanks, which can thus be eliminated.

The Bureau of Mines has estimated that "the loss from evaporation alone in a wildly flowing well, producing oil of Cushing grade, will probably exceed 25% during the time of expulsion. This does not cover losses in handling and storage. The gas, of course, is wasted. Not only do the so-called dry gases escape, but during their rapid exit from solution in the oil they carry away much of the lighter oil fractions as vapor."

ALL the oil and gas produced in these new flush pools has been handled with separators. They have (1) effected a very large saving in oil, (2) preserved the original light gravity of the oil, (3) made available for gasoline manufacturers and for subsequent recycling through the wells all the gas produced, (4) eliminated the danger of fire and explosion due to oil soaked environs, and accumulation of gas in depressions near the location, and (5) reduced the claims for crop damage. This last item is small in actual amount of money involved, but is large in the amount of annoyance and trouble saved.

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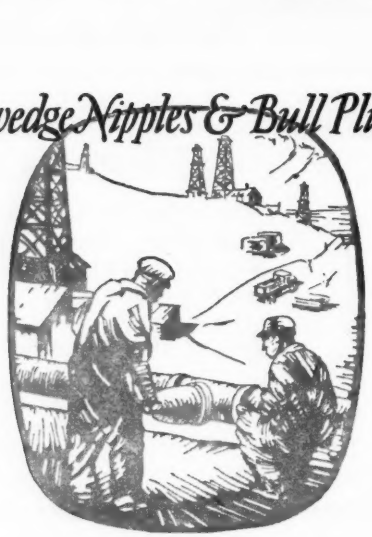

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Temperature and Pressure Instruments In Natural Gasoline Plants

By W. C. Begeebing *

IN ANY "recovery" operation or process, rigid economy is the first requirement for financial success. This explains why the natural gasoline industry early recognized the value of indicating, recording and controlling instruments. The plant operators realized that their process was essentially one of temperatures and pressures; that these temperatures and pressures must be maintained at certain stages within a narrow range; that this desired uniformity could not be obtained by manual manipulation which was moreover expensive from the labor standpoint.

So they adopted indicating and recording thermometers and pressure gages to tell them what their conditions were and employed automatic controllers to secure these conditions without labor or chance of error. Level was another factor which was placed under accurate and dependable automatic regulation.

In the following the use of temperature, pressure and level devices is outlined.

Gathering Lines and Vacuum Stations

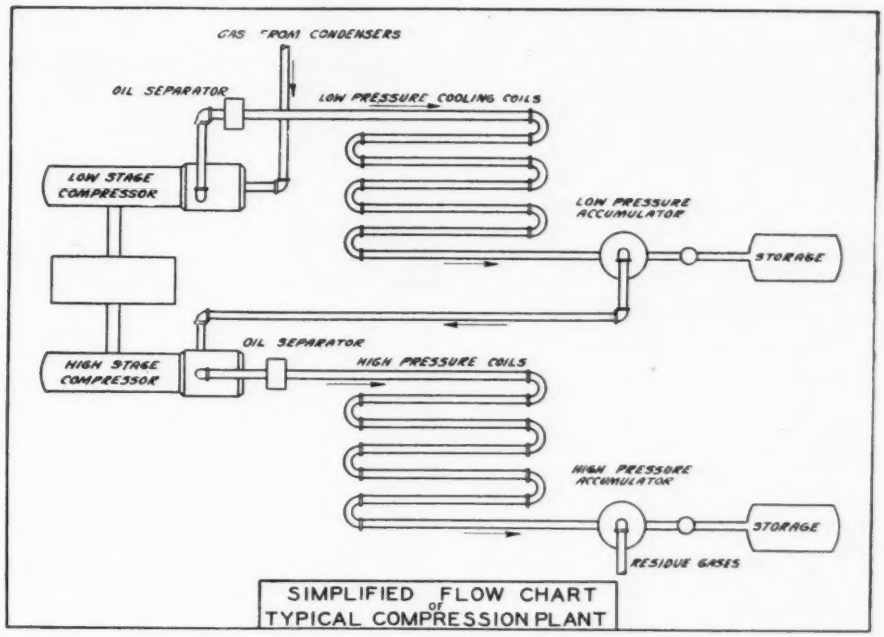
ON THE suction lines leading from each lease in to the vacuum pump station a recording vacuum gage is necessary, to determine and by which to regulate the amount of vacuum carried on the wells. It is usual to carry this vacuum at a constant point agreed upon with the lease owner and a permanent record eliminates disputes. A recording thermometer should be installed so that the proper correction can be applied in determining the cost of the gas. The discharge line from each vacuum station should also be equipped with a recording pressure gage for checking line losses and also for maintaining vacuum station capacity.

A recording pressure gage should be installed on all residue gas lines, as this record is often involved in questions of payment for the gas.

Gas Compressors

IN PLANTS where the gas is compressed in two stages, it is desirable to have the low-stage and high-stage compressor carrying the same load.

Assuming that the temperature of the suction inlet temperatures of both stages are equal, then the temperature of the gas dischaged from both compressors will be the same. Recording thermometers should be placed in both intake and discharge of both compressors. The suction inlet to compressors should be fitted with recording pressure or vacuum gages for compressor capacity rating purposes. The discharge pressures should also be recorded.



SIMPLIFIED FLOW CHART OF TYPICAL COMPRESSION PLANT

Coolers

A CONTINUOUS record of the cooling water temperature in the box condenser or in the cooling tower pool should be provided by a recording thermometer. A record of the gas temperature leaving the cooling coils should also be kept.

Accumulators

ANY gasoline which condenses is collected in the accumulator tank which should be maintained at a uniform level by means of a liquid-level controller which automatically regulates the "blowing" of the gasoline to storage or into the make tank where it is blended with the naphtha. Automatic control is necessary because if the level becomes too high, gasoline will pass along to the high stage compressors; if the level becomes too low, gas will be blown into the make tank, which is dangerous. A high pressure type liquid-level controller should also be applied on the high pressure accumulator. In this case, too high a level would mean that gasoline would go out into the residue gas lines to the field and be a total loss.

*C. J. Tagliabue Mfg. Co.

Absorption Towers

IN THE absorbing tower the cold oil dissolves the gasoline vapors and collects at the bottom of the tower where a level controller should be installed to maintain a seal and to handle the discharge of the charged oil. If the oil level in the absorber becomes too high, its efficiency is impaired. If all the oil were to flow from the tower, gas would follow creating a very dangerous condition in the system.

The temperature of the oil which collects at the bottom of the absorbing tower is a very important factor, especially during the summer months because the lower the temperature prevailing in the tower, the higher the absorbent power of the oil. A recording thermometer or an industrial thermometer should be used at this point.

Heat Exchangers

THE charged oil passes through a heat-exchanger and a preheater and enters the stripping or denuding still. Recording or industrial thermometers should be installed on the hot oil outlet of the heat exchanger and on the old oil outlet.

Stripping Stills

THE still may be straight steam, straight fire or combination fire and steam. In any case automatic temperature control should be used to

insure maximum throughput, uniform end point and uniform evaporation. If the still is gas-fired, a diaphragm valve on the gas line of the burners operated by a controller with its bulb in the still will maintain the required uniform temperature.

The diaphragm valve should be bypassed or some other provision made for maintaining a pilot flame at the burners. If it is desired to regulate the steam, the diaphragm valve is installed in the steam inlet line. When both live and exhaust steam are used in heating these stills, the use of a duplex temperature controller is recommended.

The duplex controller regulates the admission of exhaust steam to the still and whenever the exhaust steam is insufficient to maintain the desired temperature, enough live steam is admitted to supply the deficiency. A recording thermometer on the still is, of course, an absolute necessity for checking up plant operation. The oil level in the still should be automatically maintained at a uniform point by a liquid-level controller.

Most plant operators feel that the operation of the stripping still cannot be given too much attention, since on the efficiency of this apparatus depends the efficiency of the plant. The value of automatic and continuous control at this point cannot be overemphasized.

Knock-out Boxes

THE gasoline vapors driven off in the still pass first through a knock-out box to knock out any heavy fractions and thus to control the end point of the condensate. The knock-out box is water cooled (sometimes oil cooled) and for control an air-operated temperature controller should be used together with a recording thermometer. Automatic temperature control of the knock-out box is one of the most important applications in the absorption plant.

Cooling Towers

THE gasoline vapors leaving the knock-out box pass to the cooling tower, where the gasoline is condensed by the cooling effect of water sprays. A recording thermometer with its bulb in the pool under the tower will serve as a guide to the operation of the water pumps. For example a rise in temperature may indicate loss of pump capacity as would occur when clearance rings of centrifugal or the packing rings of duplex pumps wear. The maintenance of the proper temperature is obviously important as too high a temperature permits valuable products to go out with the gas. Too low a temperature simply wastes water and liquefies "wild" constituents which will cause excessive weathering losses later.

Stabilizers

THE use of stabilizers in natural gasoline plants has attracted considerable interest. The stabilizer is a rectifying column connected to a low temperature kettle or still. The various condensates are expanded into the stabilizer column at various points, the lightest fractions at the top. A refrigerating effect is produced by the expansion and evaporation of the light liquids. Steam coils in the kettle maintain it at a uniform temperature and furnish hot vapors which enter the bottom of the column.

A uniform temperature differential is thus established between the top of the column and the bottom. The top is kept at a sufficiently low temperature by the refrigerating action, so that the wild vapors which leave contain no true gasoline. The bottom of the column is kept sufficiently warm by the vapors from the still so that liquids descending in the column are freed of all gaseous constituents.

By keeping all other conditions unaltered, it is possible to vary the quality of the product collected in the kettle simply by changing the kettle temperature. The kettle temperature is the controlling factor of the entire process and the necessity of automatic control at this point is apparent.

An air-operated temperature controller is recommended for this application, where temperature accuracy is so vital to the success of the process. The bulb stem is inserted either in the still or in the vapor line leaving the still, and the diaphragm-motor valve is placed on the steam inlet line of the steam coil.

AN AIR-OPERATED pressure controller is also recommended for regulation of the release of the wild vapors from the top of the column.

The admission of the liquid to the various points in the tower also can be automatically regulated. Liquid-level controllers are mounted on the accumulator tanks of the precooler condenser, intercooler condenser and aftercooler condenser and maintain a constant level by automatically operating diaphragm-motor valves on the admission line to the column.

One other instrument should be mentioned. The mixing of air with natural gas in the pipe lines introduces an element of danger, as well as a considerable decrease in the gasoline production.

The dangers and losses due to this contamination of gas with air are caused by—

(1) The formation of an explosive mixture in the gas lines,

(2) Inefficient production of gasoline because of—

(a) improper cooling after compression

(b) imperfect precipitation

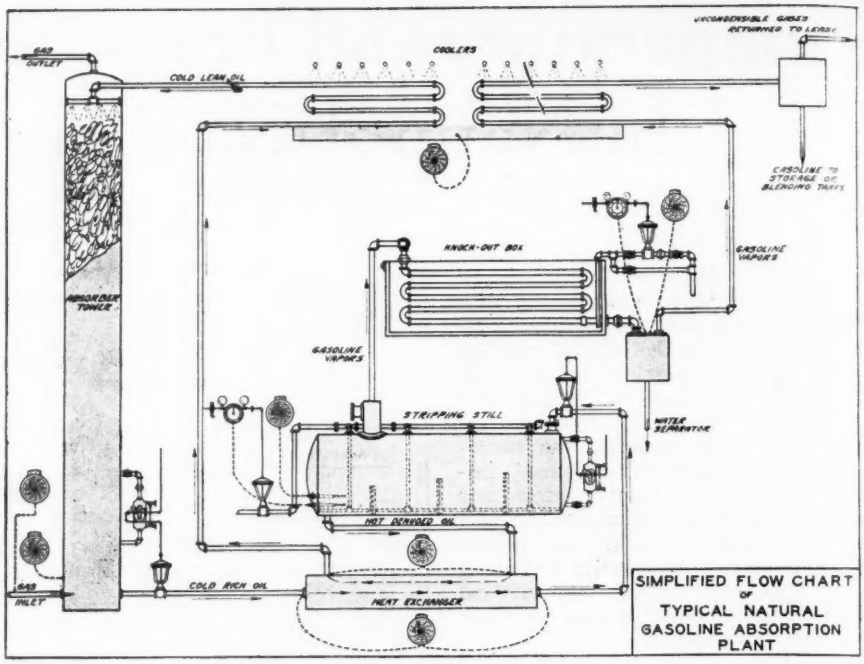
(c) increased volume of mixture to be handled and

(d) decrease of effective pressure on gasoline vapor.

(3) excessive wear and tear of the compressor equipment and accessory equipment.

Because of these dangerous and troublesome effects, the exclusion of air from pipe lines is essential to safe and economical operation.

But the detection of leaks in vacuum lines by ordinary methods is impossible. Periodical inspection of the lines by throwing them out of service and applying gas or air pressure is an expensive procedure. Occasional tests with a portable Orsat apparatus do not give the continuous information which is the only guide to the true conditions. The one method which meets every requirement is to use an air-recorder which shows the percentage of air in the gas at all times by writing a continuous record on a chart.



SIMPLIFIED FLOW CHART OF TYPICAL NATURAL GASOLINE ABSORPTION PLANT

Trend of Design in Modern Natural Gasoline Plants

By J. A. Campbell

THE past year in the California natural gasoline industry has been a busy one. New plants, with a total production of 333,000 gallons were constructed, most of them in the Seal Beach and Ventura fields. It is interesting to analyze this new construction as an indication of the tendencies in modern plant design.

It is noteworthy that over 90 per cent of this new construction use the open method cooling, either in the form of carefully designed pipe coils, or in some form of factory-built coil section.

Bubble absorbers were used in all of this construction, and 85 per cent were of the froth type.

Steam heating of the oil was used in all of these plants.

Seventy-five per cent of this construction was contracted by the producing companies to engineering firms with broad experience in the design and construction of gasoline plants.

The first gasoline plants used pipe coils for the oil cooling and gasoline condensing. The coils, though put in mostly by guess work, proved fairly efficient. Such factors as velocity, turbulence, pressure-drop, and distribution were given very little consideration. Shortly after this, closed equipment made its advent into the gasoline industry, appealing greatly to the engineers at that time because of such features as true counter-flow, the ease with which the mean temperature difference could be determined, and consequently, the facility with which the heat transfer value could be determined; that is, the number of B. t. u.'s per hour per degree of mean temperature difference per sq. ft. of transfer surface.

One of the advantages claimed for the closed equipment was its compactness. Engineers have since determined that, in designing a gasoline plant of a given size, a properly designed cooling tower containing well arranged pipe coils can be built to dimensions that will not exceed those of power necessary to cool the water for a closed system, thus gaining all the space which such apparatus would occupy.

Oil cooling is one of the main problems in connection with the design of any gasoline plant. The ultimate object is to get this temperature as low as is consistent with first-cost considerations. The wet bulb is, of course, the limit; and we remember from our mathematics that a variable approaches, but never reaches its limit.

J. A. CAMPBELL

Mr. Campbell, natural gasoline engineer, received his early education in Kentucky, graduating from Ogden College in 1911. *Entered Yale that fall as a junior and was graduated in civil engineering in* 1913. *After teaching for three years he went to California and entered the experimental division of the Union Oil Co. at the time they were doing their first experimental work with the absorption process. In* 1923 *he quit the Union to handle the engineering for the Lomita Gasoline Co., which he helped to organize, at Long Beach. That was the beginning of his entrance into the gasoline plant contracting business. He has built* 19 *plants in the last three years.*

An operator told me one time that he was cooling his oil to two degrees below the wet bulb. On checking, we found the wet bulb to consist of the ordinary wick-and-bowl type, hanging against the corrugated side of the pump house in the hot sun. Its reading proved to be 9 degrees higher than what we were able to obtain with a sling psychrometer.

MOST of the towers recently built are open-spray towers, with the sprays at the very top and turned down. The coils are so arranged that each pipe gets the spray direct, and with considerable velocity. This system of discharging the water at high velocity thru the air approximates a breeze at all times, and keeps the coils much freer from algae and accumulation of scale. The new arrangement has distinct advantages over the old drip-coils, where the coils were arranged in vertical stacks, and the hot oil came in at the bottom, and the final cooling was done in the upper pipe. This old arrangement of coils was ideal for the accumulation of scale and rapid corrosion.

More attention is paid these days to securing favorable location for the cooling tower. Where possible, the tower is located, broadside to the prevailing wind, and the coils are arranged so that all the hot piping is on one side of the tower.

The great advantage of open cooling lies in the fact that so much of the heat is dissipated by evaporation. This is very effective on the hot end, because of the high temperature difference. On next page is shown the thermal radiant across a coil of two-inch pipe, carrying 40 gallons a minute, each pass of which is 80 feet long.

It will be observed that the oil entering the coil is at a temperature of 112 degrees, and, after traveling four passes, or 320 feet, the temperature has dropped to 78, a total drop of 34 degrees. The next four passes drop this oil only 7 per cent. At the time these temperatures were taken, the atmospheric temperature was 72, water above the coils was 60, and the wet bulb 58.

The oil circulated in this particular plant had a gravity of 36, an initial of around 375, and an end of approximately 575, with a viscosity of around 45.

None of the new plants recently built in California has been equipped with static absorbers. Operators have long since realized the superiority of the bubble type, and only about ten

per cent of the production of the state is at present extracted by the tall baffle-filled towers. Over 80 per cent of the production of the state is extracted by the froth-type of absorber which is a refinement of the old-style bubble-cap absorber. A considerable amount of the remarkable increase in California's natural gasoline production the past year is directly attributable to the replacement by these highly efficient absorbers over many of the old style.

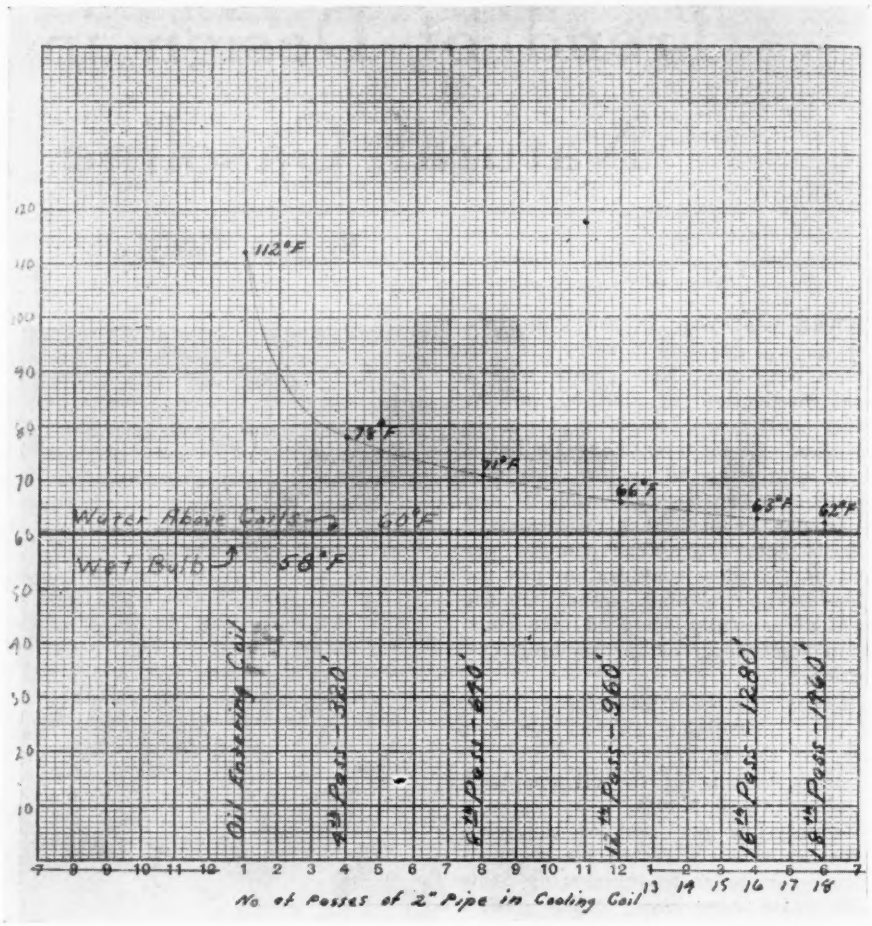
THE reason for the superiority of the froth absorber over the static type lies in the infinitely greater film area which it produces. Instead of cluttering the body of the absorber with a mass of material over which the oil in filming exposes only one side of that film to the gas, the designers of these absorbers created the film surface out of the oil itself by making the gas work this oil up into a mass of froth consisting of billions of tiny bubbles. The smaller these bubbles are, the more intimate is the contact of the gasoline vapor in their interiors with the enveloping film. Due to the action of the gas, these bubbles are broken and reformed many times; and even while intact, are being crowded by other rapidly moving bubbles resulting in a distortion of their shape and causing a stretching and contracting in such manner that the surface tension is constantly changing. This condition is ideal for bringing all the gas inside into contact with the film.

The percentage of dead cross-sectional area in the old static towers varies from 10 per cent to 50 per cent, while the dead area in a well designed froth tower is less than 3 per cent. This feature alone gives much lower velocities, thus greatly increasing time of contact.

One will find very few fire preheaters in use in California absorption plants. All new construction is using steam heaters. There are many reasons for discarding the direct-fired heaters, not least among which is the fire hazard. When shutting down a plant to change oil, or make construction changes, if equipped with steam heaters, all that is necessary is to turn the steam off the heaters and stop the pumps. When equipped with direct-fired heaters circulation must be maintained for some time in order to properly cool down the tubes.

WITH a direct-fired heater a certain amount of skin-cracking is inevitable, and asphalt fractions accumulate in the absorption oil, which not only impair its efficiency for absorbing, but are conducive to emulsification, and seriously reduce the thermal conductivity of the oil.

By far the larger part of the absorption plant construction in California during the past year has been contracted. Two or three of the large companies handle their own construction, but about 70 per cent of the work was contracted to engineering firms. There are several reasons for this. Gasoline-plant construction is a highly specialized branch of engineering, requiring the services of men experienced in this line of work. There are no large independent gasoline-producing companies, such as there are in the Mid-Continent, which are build-plants practically all the time and can, for that reason, maintain an organization for the handling of such work.



Thermal radiant across a coil of 2-inch pipe

As new fields come in, plants are built, for the most part, by the oil companies producing from that field. As speed is usually a deciding factor, it can best be secured by giving the contract to some one of the several engineering concerns sponsoring some system of absorption. Four of these well known systems of absorption-plant construction have their headquarters in, or near Los Angeles, and their operations extend not only throughout the state but are world-wide. These concerns are constantly improving their processes and are given the closest co-operation by the companies which they are serving. In this way the engineers of these contracting companies are in touch with the particular problems of all the different companies in the different fields, and, seasoned by the experience which they are constantly acquiring, are rendering more and more valuable service to the industry.

DUE to the present overproduction of natural gasoline in California and the consequent demand by the refineries for a more desirable product, stabilization is receiving a great deal of attention.

Despite all the talk that we hear of stabilizing stills and dephlegmators, selective absorption, and so on, the fact remains that there is one principle of stabilization. Although there are several ways in which it can be carried out, nevertheless successful stabilization consists in selectively discarding the extremely volatile fractions of natural gasoline.

Some operators are making a gasoline of high recovery by running hot oil to the absorbers, by circulating less oil, or by running the condensers hot. Any of these methods is costly, because of the loss of production. Hot oil to the absorbers causes the lighter, more volatile fractions to pass out with the gas and, in this way, these fractions are entirely lost. Increasing the saturation has much the same effect by forcing the absorption center higher in the absorber and by

raising the vapor tension of the oil so that the fractions, more difficult to absorb, are not recovered. A high temperature on the condenser is still more wasteful, in that it increases the velocity, raises the quantity of "fixed gases," and enables them to carry away not only the light fractions, but some of the heavier ones as well.

BY RUNNING the plant at maximum efficiency and then fractionating the finished product is the only method to use, if a maximum of production is desired. In this way, some of the more desirable of the lighter fractions may be retained, which will give the product a high gravity. The desired velocity, at the same time, shows a high distillation recovery.

The gas-lift is having its effect on the quantity as well as quality of natural gasoline production. In some of the older fields where this method is being used very successfully, many of the companies have had to greatly enlarge their plants. The gravity of the finished gasoline has dropped as much as five degrees at some of these plants, due to the heavier fractions carried by the gas. These heavier fractions have a stabilizing effect on the product, and thus help produce a gasoline of much higher recovery.

Things are rather slow at present in the California natural gasoline industry. None of the potential new fields is sufficiently advanced to cause a great amount of plant building; and, as many of the old plants have recently been remodeled, there is not a great deal of reconstruction going on. After the recent gasoline war most of the companies have adopted a policy of retrenchment and are spending very little in their gas operation. This slackening of activities has given an opportunity for more organized effort along research and experimental lines; and when the rush is on once more, the result of this work will be evident in improved design.

One factor which has had a marked effect on the industry during the past year is the benefit derived from the meetings of the California Natural Gasoline Association. This association is growing rapidly and the programs are becoming more and more interesting. By no means the least of these benefits derived from these monthly meetings is the number of acquaintances made by the members and the spirit of bonhomie which prevails. This organization has passed the crucial stage and is assured a steady growth. The program committee for the present year has mapped out a particularly ambitious program and, judging from the co-operation accorded the program committee last year, they will have no trouble carrying it through.

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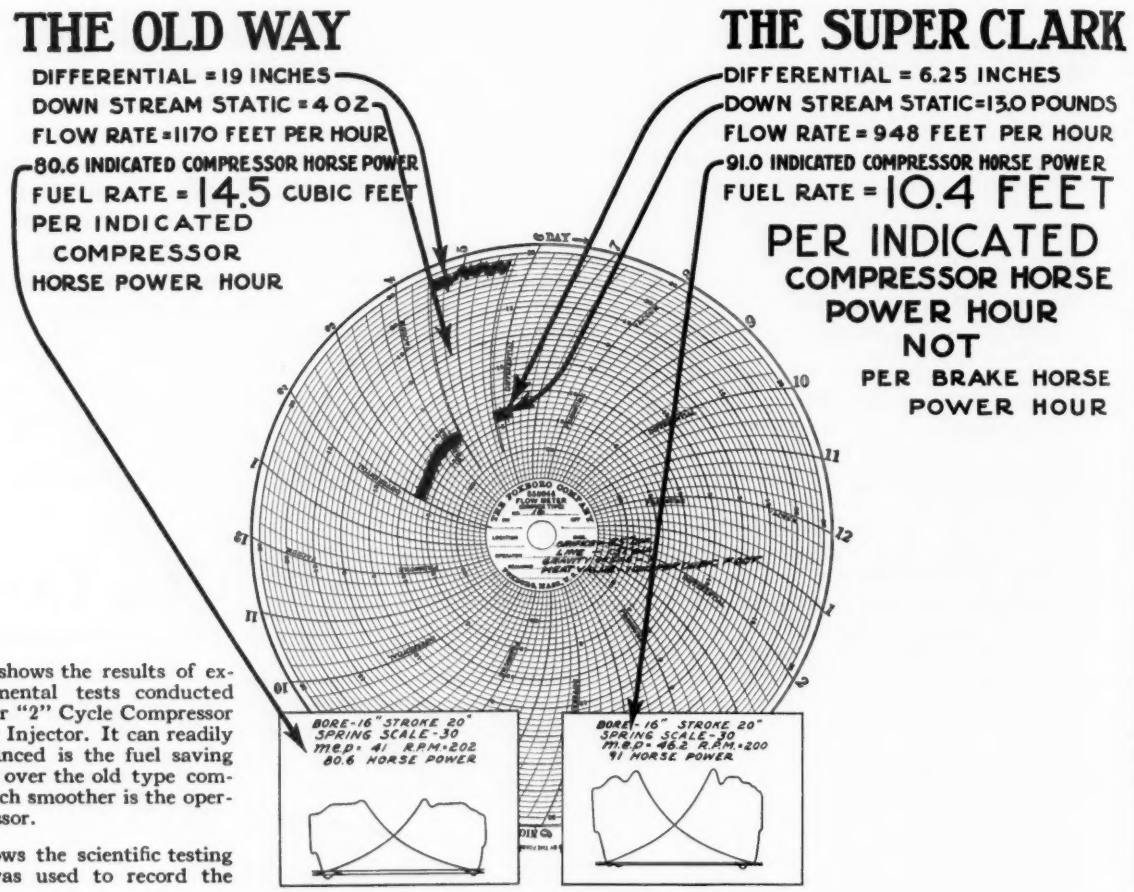
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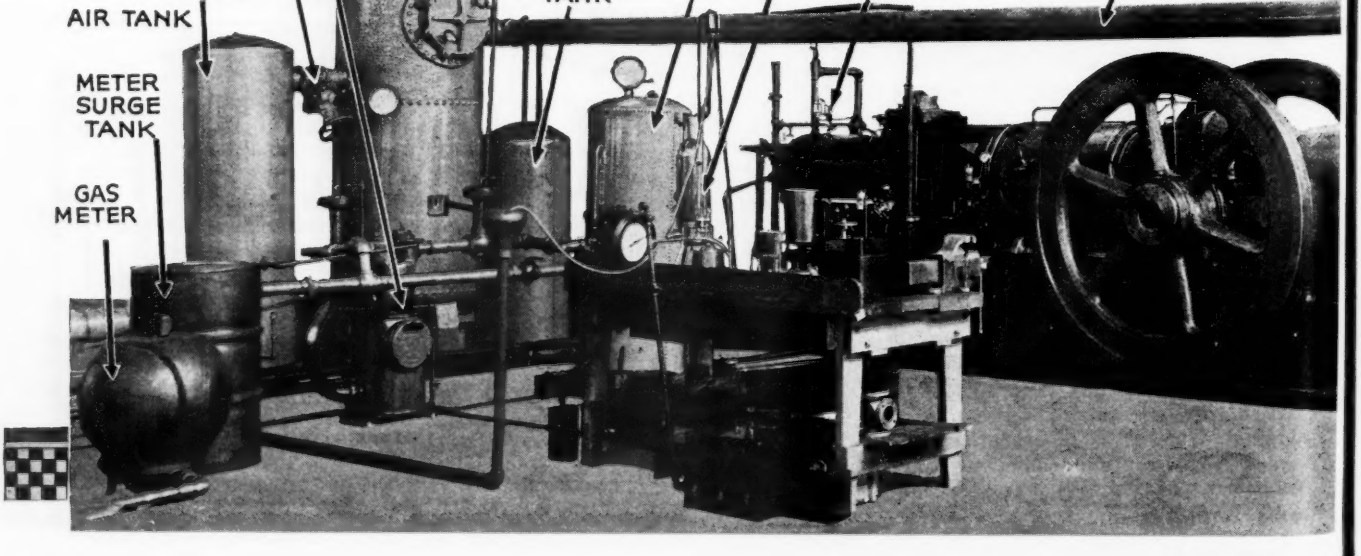
THE above chart shows the results of exhaustive experimental tests conducted with the Clark Super "2" Cycle Compressor using the Clark Fuel Injector. It can readily be seen how pronounced is the fuel saving with this new device over the old type compressor, and how much smoother is the operation of this compressor.

The view below shows the scientific testing apparatus which was used to record the operating data.



Development of Gasoline Recovery By Charcoal Method

By H. B. Hass*

THE late war was very important to the history of activated charcoal because many scientists who otherwise would never have heard of it came into daily contact with it. One of these men, G. G. Oberfell, soon conceived the idea of using activated charcoal for removing gasoline from natural gas and it required only a few simple tests to show that charcoal will accomplish this. This was a long way, however, from a successful charcoal gasoline recovery process since in such a process the gasoline must be removed from the charcoal and the charcoal put in condition to take up gasoline again.

Experiments were started as soon as possible to work out a successful method of using charcoal for gasoline recovery. Eventually the three cycle displacement process resulted and this is still the one in use. Although details and apparatus have been greatly changed so that the present plants bear little external resemblance to the first ones, the process is the same in principle.

The absorbing unit consists of three, or multiples of three, tanks containing the charcoal. These are known as "absorbers" and at any given time one will be "absorbing" or removing the gasoline from the gas, another will be steaming in order to remove the gasoline from the charcoal and the third absorber will be cooling. Each absorber goes through the absorbing, steaming and cooling processes in regular sequence. The absorption is relatively simple and consists merely in passing gas through the charcoal bed. In the next period the steam removes the gasoline from the charcoal and the steam and gasoline vapors pass out together and are condensed separately. The small amount of gasoline that condenses with the steam and the steam that condenses with the gasoline are allowed to form separate layers and the lower (water) layer is drawn off.

The gas which has had its gasoline removed from it ("stripped gas") passes out of the first absorber and is passed through a second absorber, being used to cool and partially dry the charcoal in the absorber which has just been steamed. Starting with gasoline laden charcoal, the first step is the displacement of gasoline by steam, the second step is the displacement of the steam from the charcoal surface by the light gasoline ends, ethane, propane, and butane. The third step is the displacement of the light ends by stable gasoline. The extent to which this third displacement is allowed to take place, in other words the amount of gas passed during the absorption cycle, determines the quality and yield of the gasoline, the more gas passed the more completely the light ends will be displaced and hence the less volatile the gasoline. The yield will, of course, also be smaller, than would be the case if more butane was allowed to remain in the charcoal.

EACH absorber is provided with five valves, a gas inlet valve at the bottom, a valve at the top connecting to the gas outlet header, a valve at the top leading to the "by-pass line" which conducts the gas to the bottom of another absorber, a steam inlet valve at the top of the absorber and a vapor outlet valve at the bottom leading to the condensers.

When an absorber is on the "absorption period," i.e. removing gasoline from the gas, the valve to the inlet gas header is open, the valve to the by-pass leading to the cooling absorber is open and the valves on the steam line, vapor line, and outlet gas header are closed.

When an absorber is being steamed, all valves are closed but those connecting with the steam and vapor lines.

When an absorber is being cooled all valves are closed except the one to the outlet gas line.

When a predetermined amount of gas has been passed through the plant, the valve setting is changed so that the absorber which has been absorbing gasoline from the gas is steamed, the absorber which has just been cooled is put on the absorbing period and the absorber which has been steamed is connected with the stripped gas so that it is able to cool.

THE length of a period is variable but is usually from twenty minutes to two hours. When a plant is operating on a very short cycle, it has a higher potential output per day because the charcoal is used more times but the labor requirements are greater.

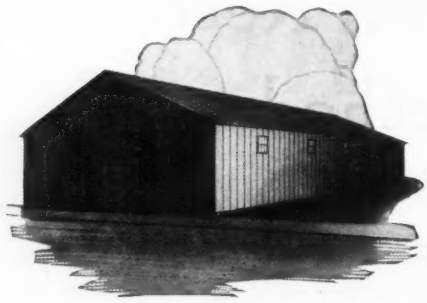
The first absorbers used were vertical cylindrical tanks with a relatively deep layer of charcoal. It is desirable however to pass gas and steam in opposite directions through the charcoal bed so that the relatively non-volatile gasoline which accumulates in the charcoal near the gas inlet side of the bed which first comes in contact with the gas, can be removed without pushing it through the whole charcoal bed. It is impossible to obtain successful stripping of the gasoline from the charcoal unless the steam is passed in a downward direction through the charcoal bed because steam has a much lower specific gravity than gasoline vapor and, if introduced below the charcoal it tends to channel its way upward instead of pushing the gasoline vapor uniformly before it as it does when introduced from above.

Horizontal absorbing and steaming have been tried with very little success because the charcoal packs more densely near the bottom of the bed and the water also tends to collect here. Hence the gas, following the path of least resistance, passes largely through the upper part of the bed where there is the least charcoal. This results in uneven adsorption and and low charcoal capacity. It is necessary, therefore, to pass the steam downward through the charcoal and it is desirable to pass the gas in a direction opposite to the steam. This means, of course, that the gas should pass upward through the charcoal bed, but if the gas velocity upward becomes too great the charcoal will be agitated and will gradually disintegrate.

IN ORDER to avoid agitation of the charcoal it is necessary to keep below a quite definite gas velocity. This is easily accomplished by using a horizontal cylindrical absorber with a relatively thin charcoal bed of large area. When the gas flow is kept at a proper rate, there is no appreciable tendency for the charcoal to powder, as coconut charcoal which is used exclusively in the United States for gasoline recovery is the hardest active charcoal made. Trouble with charcoal powdering has been reported in the case of some natural gasoline companies which departed from the proper gas rate generally in plants of their own design.

In the early history of the charcoal process it was predicted that the relatively non-volatile and high boiling constituents of natural gasoline would accumulate in the charcoal

*Research Director, Gasoline Recovery Corp.



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and ultimately destroy its activity. This factor is not troublesome, however, if the gas and steam are passed in opposite directions, for equilibrium is reached after a relatively small concentration of these heavy ends has accumulated in the charcoal. After a short time they are steamed out as rapidly as they enter the charcoal and charcoal is known to last at least five years in continuous plant operation with no measurable decline in activity after the small, initial absorption of heavy ends. When the gas and steam are passed in the same direction through the charcoal bed the heavy ends accumulate throughout all the charcoal to the concentration which would otherwise exist only in the bottom layer of charcoal and a serious decline in absorptive capacity of the charcoal does take place. This condition can be temporarily remedied by passing superheated steam through the charcoal. The superheated steam removes the heavy ends but they immediately start to accumulate again and it is much more satisfactory to pass the gas upward through the charcoal so that they can be continually removed by ordinary steaming.

A GREAT deal of unnecessary mystery has been made of the fact that charcoal takes up and holds firmly the heavy oils which are present in some gases as a mist. It is not generally realized how fine and permanent such mists may be. Some oil mists in natural gas do not settle appreciably on standing for an hour entirely unagitated. When gas containing oil mist is passed through a charcoal bed, some of the oil settles out on the charcoal surfaces and is not readily removed by steaming at ordinary steam temperatures. Mineral seal oil can be removed with a fair degree of completeness by using superheated steam at 1200 degrees Fahrenheit but very heavy crude oil is held as firmly and is so slightly volatile that even higher temperatures are required and we begin to approach the temperatures of oxidation of the charcoal by steam so that reactivation is accompanied by a weight and volume loss of charcoal. Since activated charcoal is expensive, it is much better to tackle the problem the other way and keep the oil out of the charcoal. This may be done by the use of a rock-wool filter which removes the oil mist from gas and delivers the oil on the other side in large drops which settle out.

An objection to this type of oil-gas separator as at first manufactured was that they tended to clog to a certain extent when heavy crude oil was in the gas and the resulting pressure drop was excessive. This defect has been remedied by using a thinner bed of mineral wool and a

lower gas velocity through it. One of the most recent installations is removing the suspended oil from 15,000,000 cubic feet of gas per day at the South Bend charcoal plant of the Phillips Petroleum company with a total pressure drop of only one-third pound.

These filters promise to come into use on the inlet gas to oil absorption plants also since crude oil contaminates the mineral seal oil and causes it to emulsify with the water formed from the steam used to strip the oil. In every case where these filters have been installed, the accumulation of oil in charcoal has been prevented.

ANOTHER relatively recent development is the elimination of compressors in charcoal gasoline plants. Instead of condensing the gasoline vapor, as formerly, in two stages, one at about 15 pounds pressure and another at about 80 pounds the present practice is to condense all the gasoline together at a pressure of about 60 pounds. This pressure is produced by the steam used to steam out the charcoal and, since the charcoal is hotter at the higher steam pressure it is stripped of its gasoline more readily. This means a steam economy and the elimination of a moving part, the compressor. The pumps which circulate the condensing water and the boiler feed water pumps are the only moving parts in most modern charcoal plants.

The charcoal process was first operated in Pennsylvania, West Virginia and Kentucky on gas containing little or no sulfur. When it was introduced in the Mid-Continent field on high sulfur gases the Monel metal screens used to hold the charcoal in place were corroded out with troublesome speed. Many other metals were tried with little success until a new type of screen was developed. This is called foraminated plate and consists of two superimposed pure iron plates with ⅜-inch holes. The holes are placed so that no two come opposite each other but the gas in going through the plates must pass in one hole, between the plates and out another. The distance between the plates is so small that charcoal grains cannot escape. The advantages of the foraminated plate are that pure iron corrodes very slowly under the conditions and the thick plates will withstand an enormous amount of corrosion before failure occurs.

The only corrosive condition met with in a gasoline plant which is not satisfactorily resisted by the foraminated plates is that which is caused by the simultaneous presence of air and large amounts of hydrogen sulfide in a gas. In such a case the absorber itself and the vapor lines are attacked as well as the plates, and charcoal plants are not recommended for treating such gas. Hydrogen sulfide in the absence of oxygen has very little effect and gas containing it is being satisfactorily treated by charcoal plants.

It was predicted some time ago that the charcoal process would prove to be well adapted to use in portable gasoline recovery plants. The construction of portable plants was started in 1925, the first one being finished in December of that year. These plants have been in great demand and have proved to be very popular, most of the sales resulting in repeat order.

Although rated at 1,000 gallons daily production, many of these plants have made as high as 5,000 gallons per day, a production of 400 per cent above rating, with an outlet gas content of 30 gallons per million cubic feet. The plant is shipped in four units, the condenser unit and three absorber units, all of which are put into a freight car.

It is an undoubted fact that a charcoal plant operating on a given sample of natural gas will produce more gasoline of any particular quality in proportion to gas treated than can be obtained by using the charcoal test. Although this fact has been known for some time there is not, to the writer's knowledge, any adequate explanation of the fact in the literature of natural gasoline. The difference between plant production and the charcoal test is much too great to be explained as being due to experimental error. For instance, the gas being treated at the South Rufner plant of the United Fuel Gas company tests about .410 gallons per thousand by Oberfell charcoal testing methods. Plant production is regularly in the neighborhood of .780 gallons per thousand. A portable charcoal plant operating on a Mid-Continent gas has made 168 per cent of the same charcoal test. It is evident therefore that the charcoal inlet test is not a good basis for estimating plant efficiencies.

THERE are several reasons why a charcoal test gives lower results than can be expected from an efficient recovery plant, even though the charcoal strips the gasoline completely from the gas during test. For one thing, the distillation with glycerin does not remove quite all of the gasoline from the charcoal and the gasoline remaining behind is the most stable and non-volatile part. The condensing conditions at a recovery plant, 60 to 80 pounds per square inch at atmospheric temperature result in condensing more gasoline than the atmospheric pressure and 32 degrees temperature used on test. The most important reason can best be understood in connection with a discussion of the fourth temperature rise method of gas testing.

THE charcoal method of testing gas for gasoline content consists in (1) passing the gas through charcoal (2) distilling the gasoline from the charcoal by means of glycerin and (3) condensing the gasoline distilled off and measuring it. It was early observed that maximum gallons per thousand values were obtained when a definite amount of any particular gas was passed through the charcoal absorber. Passing either more or less gas gives a lower gallons per thousand value. It is easy to see that if too much gas is passed the charcoal can be saturated to the point where it will no longer strip the gas. This accounts for low results where too much gas is passed. When too little gas is passed, the charcoal contains a large amount of ethane, propane and butane which not only fail to condense but in passing out carry with them a large amount of more stable gasoline which would otherwise condense. This is the reason for low results when not enough gas is passed.

IF A thermometer is placed in the top of a charcoal testing tube of small diameter, ¾-inch or less, and gas is passed in the bottom of the tube the thermometer will at first rise several degrees. This is because the charcoal granules near the thermometer are adsorbing methane. The charcoal soon becomes practically saturated with methane, ceases to adsorb any more and cools off by radiation, etc. After a time ethane, the next higher constituent, begins to break through to the charcoal at the top of the tube and, since charcoal will under these conditions take up more more of ethane than it will of methane, there is a second temperature rise and, as charcoal becomes saturated with ethane, the adsorption virtually ceases and the temperature falls. This is repeated for propane and, since propane is taken up in large quantities by charcoal this temperature rise is much the greatest one. When butane breaks through to the charcoal grains near the thermometer we have the fourth rise but this rise is very small. The reason is that practically the whole active charcoal surface is covered with propane and in order to be adsorbed the butane must displace the propane. The higher heat of condensation of the propane almost balances the effect of the greater capacity of charcoal for butane as compared to propane.

The test is stopped at or near the fourth temperature rise because the isopentanes have boiling points so close to that of butane that a single

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charcoal tube will not make a perfectly precise and quantitative separation between them. At this time the charcoal still contains a large amount of butane, usually much more than can be included in the gasoline.

If a second charcoal tube was placed after the first, and more gas passed through the two in series, a large percentage of this butane could be displaced from the charcoal in the first tube, and the small amount of pentanes escaping would be caught in the second tube. Actually this is what happens in a plant, where there are always two absorbers in series treating the gas. After the first few minutes of the cooling cycle the cooling charcoal can adsorb a gradually increasing amount of hydrocarbons and we obtain a much better separation between the "wild ends" and the desirable gasoline than we do undertest conditions.

THE obvious way to avoid this difficulty is to model the test apparatus to operate in the same way as the plant, but when the first miniature charcoal testing plant was built and an attempt was made to operate it in the same way as a large plant, it met with failure. Operation was found to be successful only if superheated steam was used so that the charcoal was left in a dry condition at the end of the steaming period. The reason for this can be seen readily from a simple experiment. If activated charcoal containing 1020 per cent moisture, appearing perfectly dry, is placed in a glass tube for observation at a temperature of about 150 degrees Fahr. and gas from which the gasoline has been removed is passed through the tube, the moisture in the charcoal appears in drops at the outside of the granules. This is a visual demonstration of the fact that light gasoline hydrocarbons (ethane, propane and butanes) displace water from the charcoal surfaces. The repulsion for water of a charcoal surface coated with hydrocarbons is probably due to the fact that water will fail to wet a surface of any kind which is thoroughly coated with hydrocarbons. A glass capillary with a coating of heavy grease will repel water in much the same way that a clean glass tube will repel mercury.

If the experiment is repeated with the charcoal at ordinary temperature, the water is not displaced. For this reason in a small plant where heat losses are much greater per unit volume than in a large plant, the charcoal cools down before the displacement is complete and the adsorptive power of the charcoal is much reduced.

This difficulty can be obviated by drying the charcoal by using superheated steam during the steam period, or by using a steam jacket around the absorbers in the testing plant.

The steam jacket prevents heat losses from the inner absorber and the charcoal will show the same efficiency as in a large plant.

WHILE these test plants are not suitable for field testing, they may be set up at a recovery plant and, when operated on inlet gas, will afford an accurate and convenient means of estimating plan efficiencies. They may be operated continuously or intermittently and the only work involved is the turning of valves and the measuring and testing of the gasoline produced. One company engaged in the manufacture of natural gasoline has installed these testing units at its recovery plants. It is believed that these plants provide the industry for the first time with a really precise and practical method of determining the efficiency of a gasoline recovery plant.

A question which is very much discussed in the natural gasoline industry is the relative efficiency of the charcoal process as compared to various oil absorption process. The charcoal testing method has come into almost universal use for determining the gasoline content of lean gases and it is customary to compare plant production with the gallons per thousand cubic feet shown by the charcoal test. If the plant is as efficient as the test, it is rated as one hundred per cent efficient, and since the test is usually not more than 60-90 per cent efficient we have an anomalous situation. The writer knows of an oil plant which was treating gas of about .800 gallons per thousand content as determined by the charcoal test. The plant was making the same yield as the charcoal test showed and was rated as one hundred per cent efficient, but the outlet gas from the plant tested .150 gallons per thousand by the charcoal test. A miniature charcoal plant on the same gas produced 1.200 gallons per thousand with no gasoline at all in the outlet gas as tested by the standard method.

The above tests are typical of the results experienced at a large number of plants in the West Virginia field which have changed from the oil absorption process to the charcoal process. The increased yields are much greater than were to be expected from the ordinary charcoal test applied either to inlet or outlet gas.

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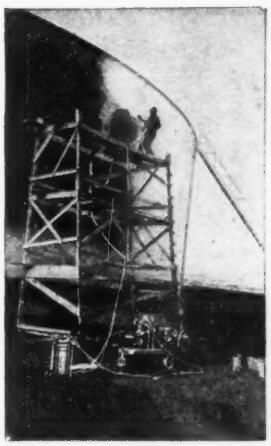

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Evaporation Loss Control *in the* Producing Division

By Charles P. Buck*

THE problem of evaporation loss in the producing division is one of widely variable conditions. The practical control of this loss must be adapted to the economic situation in many ways. Just how this most efficiently may be done depends on a number of factors. The problem has always to be solved on the basis of a profitable return on the investment and operating expense involved.

For example, evaporation loss control for the fully integrated company, owning its natural gasoline plants, pipe lines, refining facilities and storage, is a problem radically different from that of the operator concerned with production only.

In the first instance, with ample gasoline plant facilities available, stripping of vapors from the crude on the lease, in the greatest degree possible, serves to effect a marked reduction of loss in the succeeding operations of pipe lining and storage. Such completely integrated operator thus makes a markedly greater total profitable recovery from the producing property, although the whole result may not appear in the records of the producing division alone.

In the second case, however, the posted price being based on the gravity of the crude, the producer is concerned principally in delivering the maximum amount of crude, in the best gravity price bracket possible to attain.

These two instances illustrates the two extremes of the problem. There are intermediate variations but a consideration of these two will develop those factors that can be weighed for any combination of intermediate variables.

In either case, the ratio of the loss to volume of production measures the spread in which investment in equipment and operation for control can profitably be exercised.

Early research in the field of evaporation loss developed that in the author's experience, vapor tight tanks maintaining a relatively slight pressure on the crude fresh from the well served to almost wholly prevent loss by evaporation on the lease.

Just what it is worth to the producer to effect this measure of prevention can best be shown through a comparison of losses by evaporation on the lease both from open tanks and from tanks built and equipped to maintain the required degree of pressure.

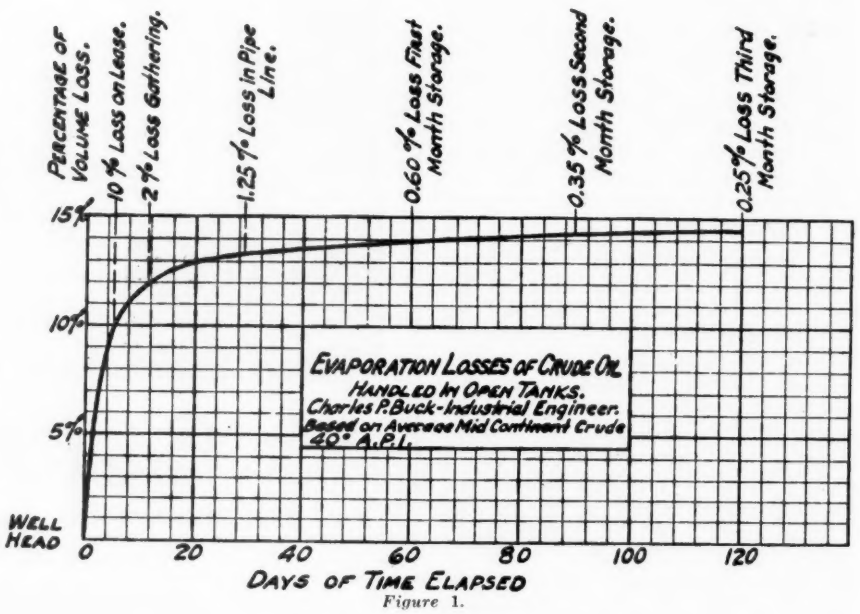
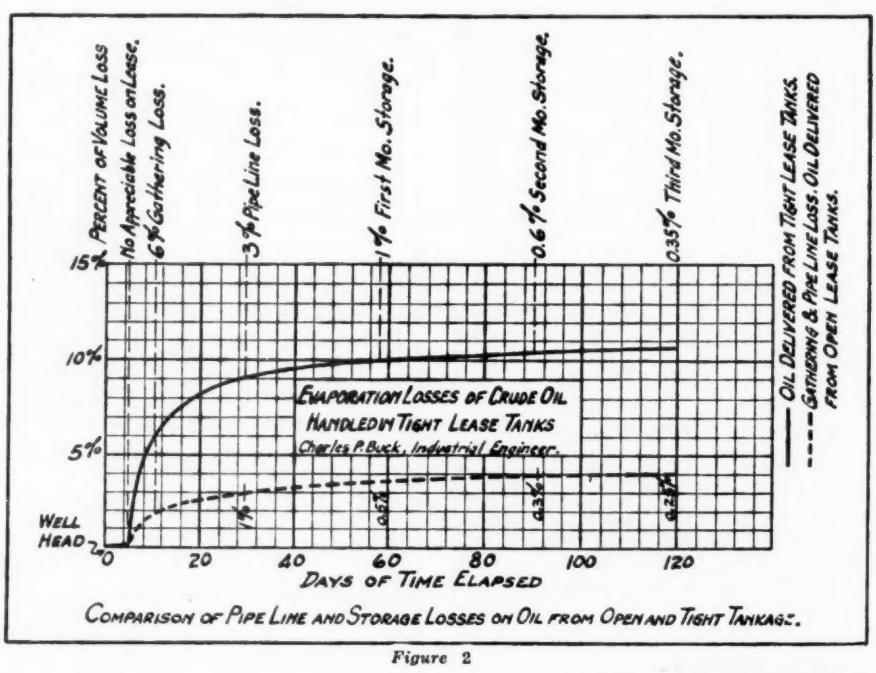


Figure 1.

Chart Fig. 1 is of losses from open tanks—(tight tanks with thief hatches open are virtually open tanks). These are average losses, and the curve is an average curve. It has been called to the author's notice by many experienced production men that they have had losses exceeding those shown by the curve. In his own research he has found greater losses in many instances, and should open tank practice continue as it did at one time, the production of crude from the deeper sands would make even this average curve altogether too conservative.

Chart Fig. 2 is a correspond-



Comparison of Pipe Line and Storage Losses on Oil from Open and Tight Tankage.

Figure 2

*Gustin-Bacon Manufacturing Co.

ing curve of loss from properly equipped and operated tight lease tanks carrying a sufficient pressure to prevent the escape of vapors. On this chart, the curve of Chart 1 is imposed for comparison. It will be noted that the lease losses of Chart 1 almost wholly disappear in the curve of Chart 2.

Experience of the industry since the introduction of the vapor pressure tank has thus demonstrated the practical feasibility of bottling up the oil so tightly as to deliver crude at well head gravity to the pipe line. But the effect of this practice on succeeding operations of pipe line transportation and storage is well shown on Chart 2. The savings made by the producing division are dissipated and lost in the succeeding operations.

It has been remarkably interesting to note the savings on the lease effected by efficient tankage. This phase of study of the problem, is of course, readily and graphically checked by comparison of run tickets on a "before and after" basis. This method has the merit of effecting a comparison on a readily grasped basis of actual commercial practice.

In many instances the savings shown by properly designed, equipped and operated tanks amount to as much as 10 to 15 per cent of the lease production. Considered in terms of settled production, the production value of good, tight, properly equipped tanks can thus be readily measured against their cost. If settled production is worth $1,000 per barrel, a saving (or increase) of 10 barrels on a property is worth $10,000. It is just like adding 10 barrels of settled production to the lease.

PROBABLY it is true that the one argument the salesman has advanced to the producer which has most influenced his purchase of "gastight" tanks has been that these tanks would raise the gravity of his crude, and consequently give him the benefit of a higher bracket in the posted price. The practice of purchasing crude on a gravity basis has followed the increasing demand for light crudes rich in gasoline.

There are two factors which may and probably will, have a considerable influence on this practice in the future. These are the increasing efficiency of natural gasoline recovery practice, and the widespread introduction of cracking equipment by the refiners. While it is true for the time being that the great volumes of high-gasoline crudes now available to the refiner have apparently given a considerable setback to the cracking process and the natural gasoline manufacturer, it yet will undoubtedly be true that this is but a temporary condition, and it is likely that the real value of the efficient lease tank will be considered more on a basis of its actual volume savings.

The relation of gravity loss to volume loss is well illustrated in the curve of Chart Fig. 3 which is based on a very considerable study of oils in many fields, and (is like Charts 1 and 2) the results obtained by the author checked with those of the Bureau of Mines, and of major companies who have done valuable work in this field.

There can be no real question but that the saving of these volume losses is economically more valuable than the gravity loss which is superficially the more potent argument for efficient tanks. Chart 3 also illustrates how necessary it is that the lease tanks be brought to the highest degree of efficiency.

Chart 3 discloses the essential profit for the fully integrated company in stripping all the gasoline vapors possible from the fresh crude on the lease. Inasmuch as the underlying basis of evaporation control is the vapor tight lease tank, this will be considered first. But first the tankage problem at the lease itself must be taken up.

WHEN a well is drilled in, production of both oil and gas is at its peak. The period of flush production calls for a capacity of tankage very greatly in excess of settled production requirements. Provision must be made for the separation of oil from gas, water, sand and sediment from wells flowing either naturally or artificially by air-gas lift.

In flush fields of the past there has been unavoidable waste of gas, and consequently of gasoline vapors. It was then economically unprofitable to build gasoline plants and gathering lines of great enough capacity to carry the peak volume. Tremendous volumes of gas were exhausted into the air and lost. Modern production engineering, however, has greatly changed this. Control of oil-gas ratios avoids waste of gas, avoids extreme and wasteful peaks, extends the life of the field and makes it possible to plan adequate natural gasoline plants of more extended useful life.

The influence of deeper drilling on future evaporation losses will become of increasing importance, for two principal reasons. The author some years since, called attention to the influence of fixed gases dissolved in the oil on the evaporation rate. On testing vapors from tanks of oil, both fresh on the lease as well as in storage, it will be found that considerable proportion of fixed gases are present. It is obvious that such gases, dissolving out of the crude, tend to release and carry with them the gasoline vapors that are the cause of evaporation loss.

Gas is dissolved into oil under pressure. The greater the pressure, the more gas will the oil take up. The industry is now drilling to far deeper sands than was the rule but a few years back. The trend is continually for deeper wells. And the deeper the sands, the greater becomes the pressure on the oil, and the more fixed gas will it dissolve.

CRUDE from the Wilcox sand of Seminole, for instance, with its 4300-foot wells, has a high evaporation rate, and one of the problems of storage is the initial elimination of the fixed gases which undoubtedly help to cause it. The fixed gases in Seminole crude are peculiarly persistent and the effect is noticed long after the oil has left the producer's tanks. This situation undoubtedly forecasts a serious problem of successful conservation that lies ahead as wells go deeper.

From the producer's angle, the air-gas lift intrudes another problem—that of elimination of the air or gas from the oil in as great degree as possible before running to stock tanks.

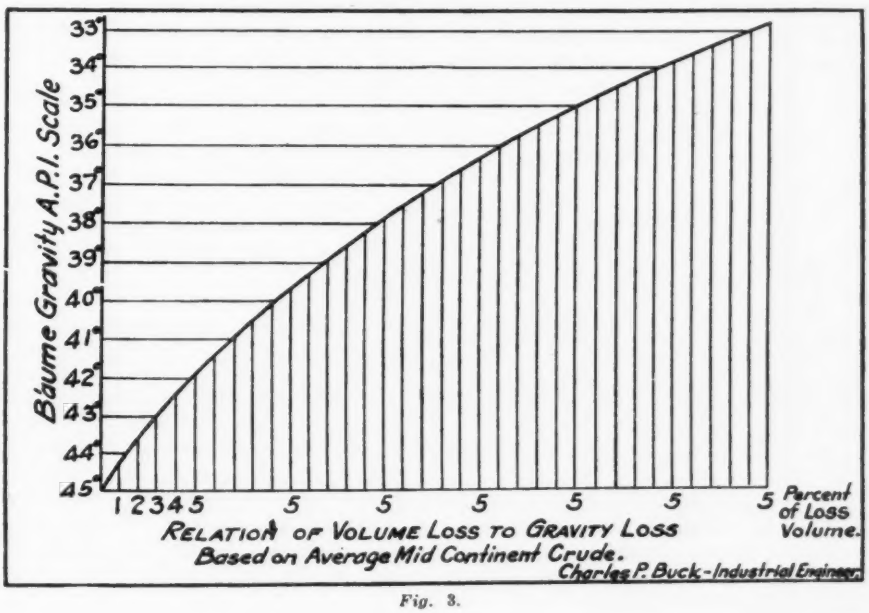


Fig. 3.

This calls for care in selection of the type of separator installed.

With deeper wells, the air or gas lift is becoming of prime importance and of necessity the gas trap or separator either without or with the flow tank, is an essential part of the tankage system. Where gas is used as the lifting medium, and the cycle is a "closed system," wherein scrubbed gas from the separator goes first to the natural gasoline plant where gasoline fractions are knocked out, and then is returned to the compressor to be cycled through the well, evaporation loss is eliminated in this first stage of production.

If, however, air is the lifting medium, and is merely scrubbed in the separator and then exhausted into the atmosphere, the loss of gasoline vapors may readily assume such proportions as to cause a serious dissipation of valuable gasoline. It is not only difficult but dangerous as well to attempt high compression of air-gas vapor or air-vapor mixture. The mixtures very readily become of such proportions as to be violently explosive. Naturally, the gasoline plant must exercise great care in handling vapors from the air lift, and must keep a careful check on the air content. Even so, the operation is an expensive one and wasteful of compressor power and capacity. Continued use of air as the lifting medium indicates the essential necessity of study to overcome gasoline loss in this operation.

THE separator manufacturer's problem becomes acute when it is considered that he must provide a piece of equipment to handle peak heads of large volume (as when wells are started or "cracked") and as well provide a high efficiency of operation on normal flow.

There has as yet been too little general study of this problem of elimination of fixed gas dissolved in the crude. In the author's opinion, that method is most efficient which handles the incoming fluid as quietly as possible, and yet exposes the crude in a thin, smoothly flowing sheet within the separator. This, so far as he has been able to check it, releases more gas from the crude than where violent agitation is permitted.

Where oil-gas separation is made in a separator, the flow tank ordinarily becomes a mere settling tank between separator and stock tanks. It can, however, be made a valuable adjunct of the separator in the elimination of fixed gas from the crude. Time and exposure are functions of the release of dissolved gas from the crude. A relatively large diameter flow tank, arranged for tangential intake so that the crude is exposed on the wall of the tank, will serve to release a considerably greater portion of gas.

In any case, where used with a separator or trap, the flow tank should be equipped like a stock tank, except that the thief hatch is unnecessary.

The flow tank should be set for the 1-pound pressure which is sufficient to eliminate evaporation loss, or as much greater pressure as is necessary to conduct gas to pumping engines, camp lines, etc. Usually, however, the gas is sold to the natural gasoline manufacturers who return residue gas for lease and camp purposes.

In the case of flush production where the separator is not used and the flow tank is depended on for separation effect, or where it becomes a matter of serving pumping wells which may or may not head up periodically, care should be taken to properly equip the flow tank to meet the conditions present.

The equipment of the flow tank must provide a sufficient relief valve capacity to protect the tank for the maximum peak as wells head up or should gasoline plant gathering lines be shut off. The type of valve selected should embody the essential characteristics of the stock tank valve. It should be large in capacity and the curve of operation should be flat in order to avoid building up of excessive pressures as wells head up. It should be readily inspectable. Material should be such as will insure reliable operation under corrosive conditions.

The volume of gas present, especially the volume at peak heads, should be carefully checked and a sufficient number of valves set to afford relief capacity that will thoroughly protect the tank, the capacity should be figured at the relatively slight pressure permitted by the strength of the tank.

THE majority of lease tanks today are of bolted construction. It is not a difficult matter to design, manufacture and erect bolted steel tanks in the usual lease sizes—up to 1000-barrel capacity—that will initially withstand a pressure of 1 pound. The real problem, however, is to make the bolted seams hold indefinitely at this pressure. It is quite the usual experience that tanks originally set to hold one pound will fail to hold one-half pound or in fact, hardly any pressure at all after a period of use.

The leaks occur most frequently in the deck seams. Failure is due in large degree to the stretching of deck sheets and seams by walking on the decks for gauging, examination of equipment, etc., or by stresses induced by excessive pressure or vacuum.

The seams of bolted tanks are made up with a yielding gasket. This gasket tends to harden, or vulcanize, with exposure. Where the decks are made of the usual light steel sheets, the sheets themselves yield between bolts. In many oils there is present considerable sulphur in varying forms and this undoubtedly hastens the hardening of the gasket in some degree as well as hastening corrosion of the deck sheets.

Where it is necessary to use the bolted type of tank, the deck should be made of considerably heavier steel and the deck seams especially should be reinforced with a proven gasket cement which will not harden, but remain in some degree elastic. This care in the setting of the tank entails some additional expense. It should be borne in mind, however, that this expense is well worth its cost in the continued efficiency of the tank.

WHERE possible as in the case of settled properties a more permanent type of tank is well worth its cost. Such a tank can be of welded or riveted construction, but in the case of flush properties such tanks are of limited capacity, and the bolted type of tank in the larger sizes where required is more economical. When the lease has settled, however, to the point where the smaller tanks can be used, the replacement of the bolted by the permanent type of tank, is well worth while. The production superintendent will do well to watch this situation.

Most leases remain over-tanked for too long. Many times an actual economy of tank equipment can be attained, especially by large operators, by cutting down the large bolted tankage on settled properties, and using it for new operations. Too large tanks are a source of evaporation loss, because there is too great an area of oil exposed in tanks of large diameter, wherein diminished production accumulates slowly.

Vacuum and pressure relief valves are necessary for the proper protection of any tank that is really tight. Some pressure is essential. The 1-pound pressure per square inch is principally effective because it is slightly in excess of the expansion increase of the gas and vapors in the tank by reason of temperature rise. Thus, this pressure will serve to hold all the gas and vapor within the tank for a rise in temperature of about 40 to 50 degrees Fahr. There are, however, large numbers of stock tanks in use which cannot carry this pressure. These tanks are profitably being made vapor tight by gasketing the seams of the deck and manhole, and then equipped with valves set for 1 or 2-ounce pressure and 1 ounce vacuum, they make very appreciable savings over open tanks.

There has been, as a whole, too little study of the conditions under which the vacuum and pressure relief valves for tight tanks have to

operate. Too often this has resulted in designs which, for many reasons, are not sufficient in capacity or reliable in operation. In consequence lease men, in order to safeguard the tanks in their charge sometimes resort to leaving thief hatches or manholes open and so destroy the vapor-saving value of otherwise efficient tanks.

TANK valves are available in a wide range of types, including various sorts of mechanical dead weight valves, valves with springs, valves with metal seats and with composition seats, and valves embodying liquid seals in various forms. Experience however, has determined certain essential conditions that satisfactory valves must meet, as well as those features of design and construction that have proved undesirable.

A good tank valve must have a capacity (or rate of gas flow) large enough to protect the tank at the greatest rate of filling and emptying that the tank connections permit, without creating pressure or vacuum dangerous to the tank. It must work without sticking or corroding in the presence of hydrogen sulphide or other corrosive influences in the vapors. It must operate reliably, without freezing, in below-zero weather, as well as in summer when the tank deck will become so hot as to burn the hand. It must work with dry, clean gas, with gas laden with water vapor, or even (as the author has observed) with paraffin blown into the tank with gas. It must not gum up or stick if perchance the stock tank runs over, which in the case of a gastight tank, is through the valve. And it must be readily tested by the lease man, without being in any way torn down. Furthermore, it must not chatter in operation, as chatter means worn and leaky valves and seats. Incidentally the design must be such as to provide a satisfactory piece of equipment at a reasonable price. The valves, of course, should not leak.

UNFORTUNATELY valves may be of considerable area, but the passages for escape of gas so shaped as to reduce capacity below safe operating limits. Many valves are too small to begin with. Where soft seats are used, many times they are of a composition that hardens and cracks in the presence of sulphur gas and the heat of summer, or softens, disintegrates and sticks when smeared with oil, as usually occurs. The choice of spring weighted types often leads to loss, if not disaster, through the weakening of springs (or sticking) by reason of rust and corrosion.

LIQUID seals are difficult to keep in order for a number of reasons. For instance, water vapors condense and collect in the seal cups; when this occurs in winter, freezing sticks the valve. Where, as is usually the case, no means of readily testing the valve is provided, inspection occurs only at too great intervals, and trouble of more or less serious nature results—usually the pulling in or bulging of the tank.

Chart Fig. 4. The wide disparity in performance of tank valves is graphically shown in Chart Fig. 4, taken from a monograph of government investigators. When it is considered that 1000 barrels of oil per hour pumped from tanks to pipe line requires 5600 cubic feet of air per hour, to replace the oil removed, the necessity of valves of ample capacity is evident.

Generous care exercised in the selection of vacuum and pressure valves

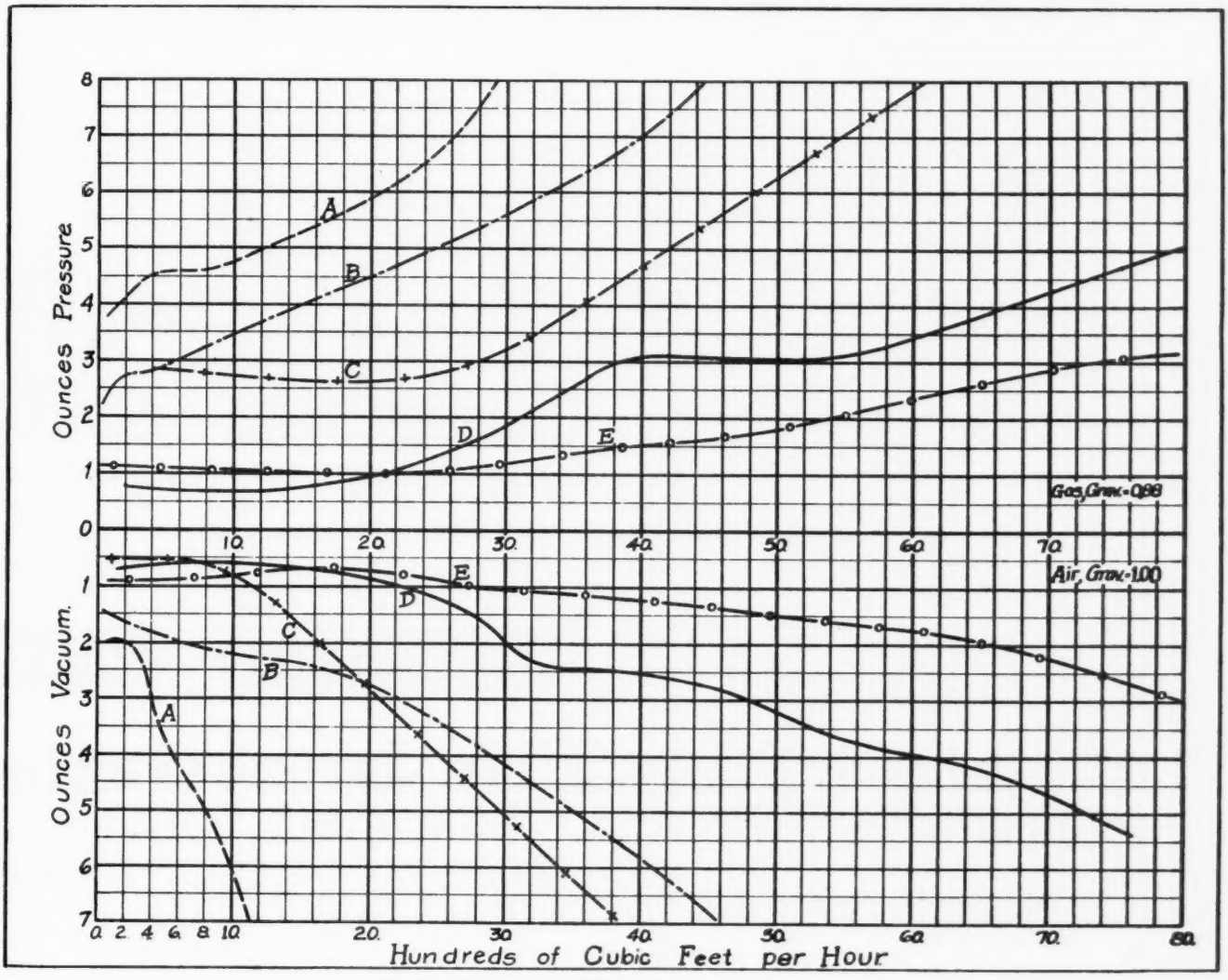
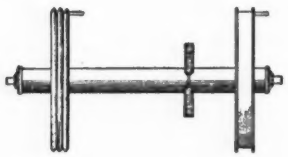


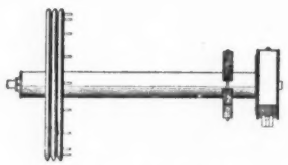
Figure 4.

"IDECO" Steel Wheels
Built for Hard Service



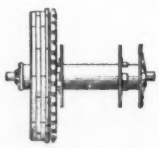
Bull Wheels

"Ideco" Bull Wheels have eight channel spokes, a deep "V" groove tug rim with rolled edges, wood or steel faced brake wheels, "Ideco" patented removable gudgeons and 13′ 6″-16″ or 18″ O. D. shafts with 3/8″ or 1/2″ walls. Turning pins, rope dogs and helpers are regular equipment.



Bull Hoists

The Bull Hoist utilizes the standard type of tug wheel, shaft and removable gudgeons, the brake has been changed to a casting 48″ in diameter equipped with Johns-Manville Brake Lining. The elimination of the antiquated type of brake has brought greater flexibility of operation, more perfect control, speeded up drilling, gives more floor room and eliminates all of the disadvantages of the old type of brake.



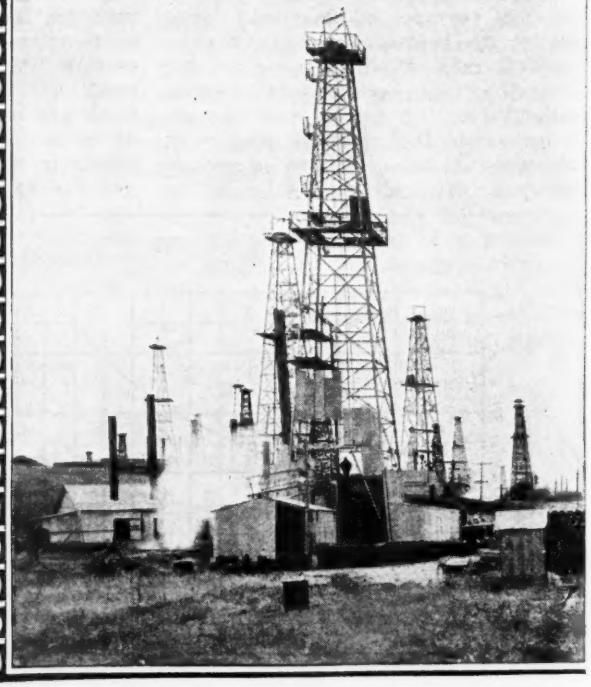
Calf Wheels

Made with wood or steel face brake wheels "Ideco" Calf Wheels have earned a reputation for great strength and long service. A 90″ sp'it sprocket, "Ideco" patented removable gudgeons and 16″ or 18″ O. D. Shafts are standard.

Band Wheels

Having superior strength and balance with a minimum of vibration "Ideco" band wheels are furnished in a variety of sizes. Their principal features are: wood or steel face rims, double channel arms, double riveted construction, a one-piece steel hub, and the "Ideco" deep "V" groove double steel tug rim with rolled edges.

All the Above Wheels Furnished Galvanized or Painted



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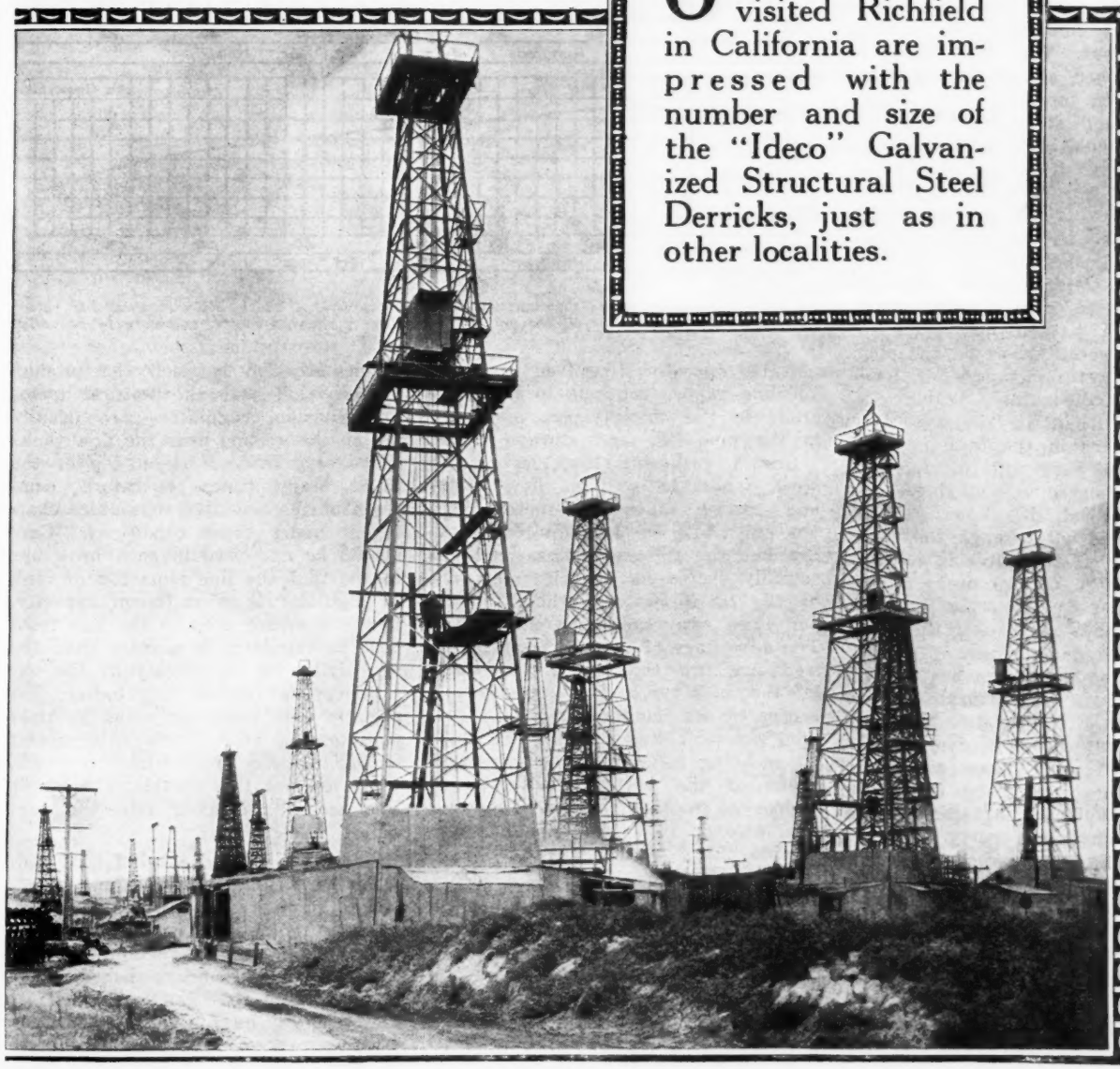
Columbus, Ohio

Export

OIL men who have visited Richfield in California are impressed with the number and size of the "Ideco" Galvanized Structural Steel Derricks, just as in other localities.



built and assembled, to the last rivet, in our own shops. They meet the most rigid de-
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oil producer wants. "Ideco" Wheels are built of the finest materials and possess tre-
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for vapor tight tanks is well repaid in the confidence and the satisfaction of the field men who become responsible for the efficiency of the tanks in use.

THE subject of thief hatches is quite as important in its way as tank valves. The thief hatch, or thief hole cover, should be tight, and convenient in operation. It should be rugged and strong, and its construction should be such as there is no possibility of the cover being locked down without being firmly on its seat. The sealing gasket is important. In general, composition rubber gaskets should be avoided, because the inevitable smearing of oil will tend to disintegrate them, or they will harden and crack.

The location of valves on the stock tank is important, vapors of gasoline have a considerably higher specific gravity than air or gas. Thus the atmosphere in the tank is much leaner at the very top in the dome than down nearer the oil level. As the tank is filled, the vapor, gas and air are pushed out through the valve. Consequently, if the valve is set low, as at the edge of the deck, a considerably greater proportion of rich vapor is exhausted than if the valve is set on the dome cover.

Conservation of vapors has a most effective ally in the natural gasoline division. Initial co-operation with this division occurred, of course, in the recovery of casing head gas. Sale of casing head gas soon became a prime consideration in the income from a producing property.

Lease tanks arranged for prevention of evaporation become immediately efficient tanks for recovery of vapors by connecting them to casing head gathering lines, with suitable automatic vacuum control.

RECOVERY of flow tank gas has been practiced for a considerable period. This recovery has not, as already noted, been as effective as it can now be made through modern methods of production control. That is for the very good reason that the gathering lines run to flow tanks cannot be made of sufficient capacity to carry the extreme heads of uncontrolled flush production. It was the common, not the unusual thing, to see tanks in a flush field popping off as some flush well headed up in a tank connected to gathering lines to which other tanks set at lower pressures were piped.

This again illustrates the value of efficient control of oil gas ratios throughout a field.

But recovery of vapors merely from the flow tank is stopping far short of realizing the full efficiency of the natural gasoline plant in the control of evaporation in the producing division, particularly for the fully integrated operator. Dissolved gases and gasoline vapors continue to leave the crude in the stock tanks, and even in the pipe line and storage tanks.

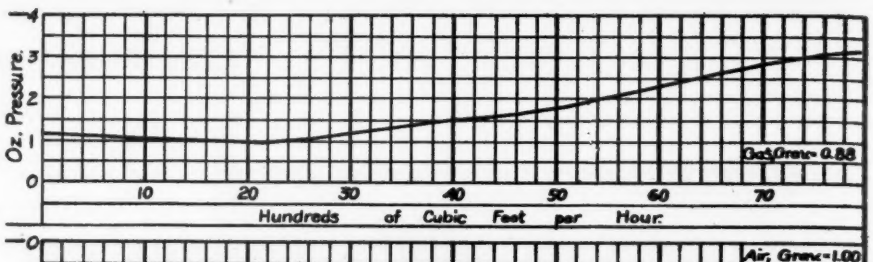

Figure 6 graphically shows the capacity at various pressures which indicates that this valve has ample capacity to pass all the gas and air, at very slight pressure, necessary to properly protect the tank.

Should gathering lines be run to stock tanks, as well as flow tanks, and vapors taken off there, there not only will be a profitable recovery but the release of dissolved gas sensibly increased. Stock tanks are usually set in battery, where the vapor lines can readily be manifolded. The advantage of manifolding is equalized pressure throughout the tanks of the battery, and a considerably decreased air content in the recovered vapors. Thus a tank from which oil is being run, draws on the other tanks of the battery for gas and vapors to replace the oil. Likewise, the tank or tanks being filled push vapors out into the other tanks of the battery through the manifold. Thus there is much less breathing of air into any tank in the battery.

IT IS not always the case that the flow tank is set near or as a part of the battery of stock tanks. Where it is so set, the flow and stock tanks should be manifolded together as there is always gas arising from the crude going into the flow tank, the probability of air in the stock tanks being in excessive proportions is greatly reduced.

Accurate control of gathering line vacuum at flow and stock tanks is vitally essential. Such control must be sensitive to the slightest change in tank pressures and the regulator must be of proportionally large capacity to insure the recovery of vapors at pressure peaks. Large capacity does not necessarily denote large size. The regulator passes normally but a very small ratio of its peak capacity. It must, therefore, be of a type that assures constant regulation over its entire capacity range, for constant and close regulation is vitally essential to successful vapor recovery.

Because of the present sharp line of demarcation between the producing division and the natural gasoline division, regulators are usually set on the ground near the flow tanks they serve instead of on top of the tank. Many times operators complain of the sensitive regulators chattering under these conditions. Care should be exercised in such hook ups to see that the line from top of tank to regulator is of sufficient capacity. If the pressure drop in the line from tank to regulator is greater than the sensitivity of the regulator, the instrument is certain to chatter, especially with relatively small volumes passing. In such cases enlargement of the line, say from 4-inch to 6-inch, will overcome this trouble. The larger line may be swaged into the regulator inlet.

There has existed a belief that high vacuums within the tank are essential to complete vapor recovery. Such, however, is not the case. The slight effect of the partial vacuum thus attainable may be accomplished, when it is realized that the crude and its dissolved gas have been released from a pressure of 40 to 90 atmospheres in the sand, and the further gain of one fourth to one half an atmosphere practically attainable is negligible.

The hook-up in the flow tank must be such as to continually remove the stratum of vapor of high specific gravity that forms over the surface of the crude and this is most practically accomplished by extending the gathering line within the tanks until its mouth is but 10 inches or 12 inches above the surface of the crude. This has the effect of causing the lighter gases to sweep over the surface of the oil, picking up the heavier vapors and carrying them into the gatherline.

It is better to carry the pressure in the tank above but as near to atmosphere as possible. Regulators are available that open at ¾-inch water column pressure, and close at atmosphere. This has the effect of

materially reducing the air content of recovered vapors, which would build up under vacuum, due to slight leaks in the tank decks or equipment, and also of preventing undue vacuum stresses on the tank which might create leaks. The natural gasoline division, as every operator knows, spends a good part of its activity in fighting air content in the gas it treats.

In conclusion, the producing division will earn greater dividends—secure a greater volume production from its properties both in crude and in dollars and cents—if it will wholeheartedly co-operate with the natural gasoline division in the equipment of its properties with efficiently operated vapor saving tanks (now obtainable as standard product from many reputable manufacturers) and carefully considered, effective and complete vapor recovery systems.

Brings Out New Line Of Diesel Engines

CHICAGO, Sept. 19.—A line of higher speed, lighter weight Diesel engines in ratings from 30 h.p. and up, for belt drive or for direct connection to driven machinery, is one of the recent developments of Fairbanks-Morse & Co., with headquarters here.

These engines have been developed as a result of the rapid widening of the field of application for this type of prime mover, whereas previously developments have been with larger sizes only.

In this engine the fuel oil is injected into the combustion space above the cylinder proper by a plunger pump which is driven on a cam mounted on a shaft running along the side of the engine about half way up. The fuel is sprayed through a nozzle at the top of the cylinder and the injection of the fuel is timed so that it enters the combustion chamber at about the time the piston reaches the top of its stroke.

The new Diesel is equipped with both manual and governor control, which is an important feature where the engine is used for such service as a power shovel, and it is also useful in varying the voltage or frequency on direct and alternating current generating sets.

The engines are built in a number of modifications to meet virtually every service requirement. They can be equipped with radiator cooling and with a built-in clutch of the automobile type for such applications as dredges, power shovels, locomotive type cranes, etc. The direct connection of a small alternating current generator with direct connected exciter is another modification, this being the first time, the company claims, that a full Diesel engine alternating current generating set has been available in sizes as small as 36 kilowatt.

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Getting the Most Steam From Oil Field Boilers

By Rex G. Hamaker *

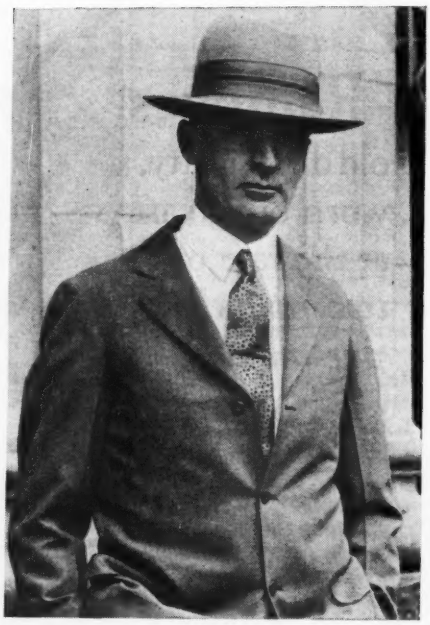
MUCH has been written from time to time. of the history, design, construction, installation, maintenance, operation and repairs of oil field boilers and there are available boiler codes, published results of studies and experiments made of boiler efficiencies and boiler losses, which the progressive firemen will obtain and give intense study to.

The American Society of Mechanical Engineers has long since published a boiler construction code, which has been revised from time to time. This code has formed the basis of other codes written, such as those used by the states of California and Oklahoma, and largely governed the construction of boilers throughout the country. Bulletins such as one entitled "Study of Boiler Losses," published by the University of Illinois, and those published by government departments at Washington are available for those wishing to go deeply into the subject.

An excellent paper by John R. Suman was delivered before the American Petroleum Institute at Tulsa on Dec. 8, last, which presents some very useful information concerning the proper installation and care of oil field boilers. This paper is available for distribution from the Institute.

The standardization committee on oil field boilers of the American Petroleum Institute, which committee is composed of qualified oil-field men, has developed over a period of years past an A. P. I. boiler specification governing the construction of A. P. I. boilers and a code of recommendations for the selection, maintenance and operation of oil field boilers. This specification and code has, in part, been distributed by the A. P. I. and in the near future will be ready for distribution in its completed form. Every fireman in the industry should secure a copy of this specification and code for his study and enlightenment. He will be able to obtain such copy from C. A. Young, Director of Standardization, 1508 Kirby Building, Dallas, Texas.

There are however, inasmuch as it is not possible to cover the subject of boilers completely in these short articles, some important principles of the efficient firing of boilers not followed by all firemen that should receive attention.



REX G. HAMAKER

Boiler Design

THERE are two principal types of boilers, namely the water tube boiler and the fire tube type. Water tube boilers are generally of large capacity and high pressure and used more commonly in permanent installations. There has, however, recently been introduced a satisfactory water tube boiler, portable in character and sufficiently small in capacity for general oil field use.

Fire tube boilers are generally constructed to conform to one of two designs, namely the fire box or locomotive type and the horizontal return tubular type. In oil field installations, particularly for drilling purposes the locomotive type is the most suitable because of its portability and simplicity of set-up.

Fire Box Boiler Set-Ups

IN MANY instances however, advantage has been taken of the simplicity of fire box boiler set-ups to such an extreme that it has proved detrimental to field operations. That which is desired most by firemen and steam users is the maximum amount of dry steam obtainable and frequently in the attempt to obtain this maximum amount of dry steam the object is defeated because of inefficient set-ups and inefficient operation.

In order to obtain the maximum amount of dry steam available from a given boiler certain fundamental principles of combustion and draft must be adhered to.

Combustion and Combustion Chambers

COMBUSTION, being the rapid chemical combination between the fuel supplied and the oxygen of the air supplied, results in a generation of heat; and it must be remembered that it is the heat which when applied to water generates steam rather than the fire, which is simply the process of generation of the heat desired. The heat developed, which is colorless as compared to the fire or process of combustion, has actually a higher temperature than the main body of the fire itself. It is for this reason that it is highly desirable that combustion be completed adjacent to but not against the water sheets of the boiler, which in the case of the H. R. T. boiler is the bottom of the shell and in the fire box boiler the inside of the fire box and the tubes.

It is, therefore, desirable that a combustion chamber be constructed adjacent to but independent of the boiler, whether it be of H. R. T. or fire box type. For the H. R. T. boiler the combustion chamber should be satisfactorily constructed for complete combustion at the end of the boiler under the smoke box or stack end. For the fire box boiler the combustion chamber should be constructed below the fire box of the boiler.

The combustion chambers should be tight, so as not to leak heat generated and should be of ample size for complete combustion. For the fire box boiler, it has been found desirable to construct the combustion chamber below the fire box in size equal to, or greater than, the fire box itself and to be fired from the smoke stack end of the chamber. Great care should be exercised to prevent any air whatsoever from entering the combustion chamber or the fire box except that air which is necessary for complete combus-

*Chief engineer, Humble Oil & Refining Co., Houston.

tion and which is admitted into the combustion chamber only from where the chamber is fired and where the fuel is delivered.

Because of the unfortunate composition of the air available, which is but approximately one-fifth oxigen and four-fifths nitrogen, much air has to be admitted in order to secure the required amount of oxygen for combustion. The four-fifths of the air admitted is detrimental to steaming, having only the offsetting quality of cooling rather than the desired quality of heating of the boiler water. Therefore, too much emphasis can not be put on the necessity of excluding all air except that admitted for combustion with the fuel at the burner in the combustion chamber.

Combustion chambers should be carefully constructed of good brick and mortar and lined with high quality fire brick and fire clay. Soil piled around a combustion chamber is of practically no value in preventing air leaks as it becomes completely dry when the boiler is fired and is then nothing but a porous mass.

There is additional reason for completing combustion away from water sheets or surfaces of the boiler from the standpoint of care of the boiler itself. Direct firing against the sheets and tubes of a boiler causes unequal expansion and contraction of sheets and tubes, because of the varying temperatures in the fire, or combustion process. This naturally results in warped sheets, leaky tubes and leaky stay-bolts.

Draft

PROPER draft is often disregarded in boiler firing, which results in a lessening in the amount of steam delivered. Proper draft is obtained with a correctly designed stack which has had the attention of the designing engineer or the practical experimenter to give it correct diameter and length.

Quite frequently boiler stacks are put up short because of the inconvenience in handling a long stack. A much greater inconvenience results, however, when the firemen attempt to get the steam required without the aid of sufficient stack to give the necessary draft. Generally a reputable boiler manufacturer furnishes a stack correctly designed for the boiler delivered.

A stack of correct size does not, however, solve the draft problem unless it is properly assisted with an air tight smoke box and air tight joints in the stack and air tight where the stack joins the boiler. If the smoke box door is loose, or warped to stand partly open, the draft is broken or spoiled to whatever extent air is permitted to enter the stack without having passed through the combustion chamber. A poor or insufficient draft results directly in lower steam capacity.

Boiler Capacities

BOILER capacity, or the horsepower of a boiler, is dependent upon the number of square feet of water surface available for direct contact with the heat generated in the combustion chamber for the disengagement of steam within the boiler. Boilers, therefore, like all other power units, have their working capacities and their ultimate capacities to which they can be crowded; but to secure the maximum amount of steam from a given boiler certain fundamental principles of firing as herein described must be followed.

It is not possible to get maximum power from a given engine, whether it be steam or internal combustion, if the piston rings leak badly; nor is it possible to get maximum power from a steam turbine when some of the buckets are broken or out of line or worn. Likewise, it is not possible to get the maximum amount of steam from a given boiler if conditions for efficient steaming as herein described are not met.

Boiler Feed Water

IF IT is desired to get the maximum amount of steam from a given boiler it is certainly not desirable that the water within the boiler be cooled by the injection of cold feed water. It must be remembered that whatever the temperature of the feed water injected into the boiler is, it must be raised to steaming temperature before steam can be formed. Therefore, the least amount of heat consumed within the boiler for raising water to steaming temperature the more heat is available for steaming and, consequently, more steam can be delivered.

There are both open and closed feed water heaters which utilize exhaust steam, the heat of which ordinarily would be wasted.

The quality of feed water or boiler water also has a very direct bearing on the amount of steam that can be generated in a given boiler. If the water is hard, containing scale forming elements, there will be naturally an insulation of scale formed on all steam generating surfaces within the boiler. Such a scale on tubes and other heating surfaces naturally insulates off the heat from coming in contact with the water to form the desired steam. A heavy coating of scale deposited in the boiler from bad feed water means that much heat will pass through the boiler flues and up the stack without generating steam. Therefore, a boiler coated with scale on the inside cannot be expected to generate nearly the amount of steam that a clean boiler will.

Likewise, flues must be kept free from soot accumulation, for soot also acts as insulation against the water from the heat, thus preventing the forming of the maximum amount of steam. The heavy accumulation of soot in tubes also interferes with the proper draft being drawn from the combustion chamber.

Boiler and Steam Line Protection

PRACTICALLY all firemen tending field installations where boilers are set-up in the open have witnessed what happens when rain falls on a hot boiler or steam line. It is seen that steam is immediately formed from every drop of water falling on a hot boiler or steam line. It is, however, probably little realized or known the amount of heat dissipated from a boiler or steam line when unprotected from the weather. If all of the heat dissipated from an unprotected boiler and unprotected steam lines could be conserved and put to work generating the steam desired there would be obtained a very appreciable additional quantity of steam from the given boiler and given firing conditions.

There is much accurate data available on actual losses from boiler radiation but it is neither the purpose of this paper nor does space permit to give such detail but instead to call attention to boiler operators the fact that these losses herein referred to, when permitted, are the reasons why much difficulty is encountered when attempting to get the necessary steam from a given size of boiler that should provide the steam required.

Boiler insulations are not ordinarily considered practical for temporary field set-ups, but much can be gained from the use of tight boiler houses which prevent wind or even air currents from continually taking heat from boiler shells. A tight boiler house is known to be a worth while installation even for temporary set-ups and the difference in the amount of steam delivered from a given boiler when installed in the open and when installed in a boiler house in indeed noticeable to the operator of a steam engine to which steam is being furnished from the boiler.

WORCESTER, Mass.—George W. Knowlton, III, has been elected president of the Victor Filling Stations, Inc. Victor Mandoff, who organized the company, remains as manager and treasurer. Maj. George W. K. Knowlton, Jr., who was previously general manager of W. K. Knowlton & Sons hat factory of Upton, has been elected to the board of directors.

The company was organized in October, 1926 and operates several filling stations here.

Faster and Cheaper Drilling Methods Are Present Day Necessity

By John M. Lovejoy*

THE science of extracting and utilizing the mineral constituents of the earth's crust is nearly as old as man. Students of the development of civilization estimate that it has taken over 100,000 years for man to develop from arboreal mammal, living on uncooked fruits, roots, and berries, to his present highly developed state.

The mastery of the more simple arts—the use of fire, stone implements, the bow and arrow, the making of pottery and finally the smelting of iron, involved thousands of years. Progress was slow primarily because of the inability of man to disseminate knowledge. It is estimated that the first systems of writing by graphic signs were developed only about 6000 years ago.

This step undoubtedly allowed much more rapid progress of the arts and sciences. Finally, with the discovery of the printing press and the use of paper, facilities for the distribution of knowledge and a medium for discussion was provided. Now with our large groups of scientific and technical men, progress is indeed rapid. Practical application follows fast on the heels of laboratory experimentation. This particularly applies to the petroleum industry, where the operator is now doing things which only a few years ago were beyond his most sanguine hopes.

In the development of the science of extracting petroleum from the ground and deriving its hundreds of by-products from it, the accomplishment of individuals has been notable. But the reason today that the United States occupies the leading position among all other nations respecting the production and utilization of its petroleum resources is largely due to co-operation of the practical and the technical men engaged in this industry, and in the industries dependent on the products obtained from petroleum.

PRODUCTION engineering itself is as old as most of the arts, but as a profession it is the infant among the large groups and branches of engineering. The principles of churn drilling and also of "casing" a hole were discovered and in use by the Chinese centuries ago. Quoting from Baron Richofen's letters, 1870—1872, "a slight up and down motion of the thick end of the pole makes the iron hop and bore a vertical hole with its broad sharpened edge—when a portion of the rock is mashed clear water is poured into the hole, a long bamboo tube with a valve in the bottom lowered, and the turbid water is raised to the top. For the protection of the sides of the bore-hole pipes of cypress wood are rammed in and to prevent the water contained in the surrounding ground from getting access to the well, the pipes are attached to each other at the ends . . ." So we see here bit, bailer and casing.

The first modern drilling of which we can find record was for artesian water in France. In 1821 M. Garnier published 2000 copies of his work "Traite des Puits Artesiens" containing a complete manual of the art of well drilling. In 1841, at Grenelle near Paris, a well was completed to a depth of 1798 feet after seven years of incessant labor. This was for some time the deepest well in the world. In 1857 the Passy well, also near Paris, was drilled to 1923 feet; its diameter was two and a half feet.

The rotary system of drilling in its original conception was invented by Fauvelle in 1845 and was used for some years in Europe. This system attained prominence for deep well drilling in 1901 where it was successfully used at Spindletop where other methods of drilling had failed.

A VERY comprehensive book was published in 1861 (2nd Edition; First Edition apparently 1845). This is "Guide du Sondeur" by De Gonser et Laurent. It contains many plates of drilling and fishing tools identical with those now in use. Apparently one of the next most important publications is "Petroleum" by Sir Boverton Redwood in 1890, and then in 1904 A. Beebe Thompson's "The Oil Fields of Russia."

Among the first American publications are technical papers by I. N. Knapp, Captain A. F. Lucas, Benjamin Andrews—who was a pioneer in the development of the use of mud laden fluid in rotary drilling—and Miles W. Quick, who experimented with back pressures on oil wells in Pennsylvania probably in 1905-6.

In 1911 or 1912 the Bureau of Mines became interested in problems connected with recovery of oil, elimination of waste and allied questions, and appointed Ralph Arnold as consulting engineer for petroleum. The development of the Cushing field was accompanied with such huge losses of natural gas that congress appropriated certain sums for the establishment of petroleum engineers to work under supervision of the Bureau of Mines; Alf G. Heggem, James O. Lewis, Carl H. Beal, W. F. McMurray, H. B. Goodrich and others were appointed petroleum engineers by the Bureau.

Of the early publications issued by the Bureau of Mines, the most interesting are "Mud Laden Fluids applied to Well Drilling" in 1913 by Pollard and Heggem, "Methods for Increasing the Recovery from Oil Sands" in 1917 by James O. Lewis, "The Decline and Ultimate Production of Oil Wells" in 1919 by Carl H. Beah.

THE Bureau of Mines has continued its work in production engineering and today has stations in all of the large producing districts, which are doing very excellent and valuable experimental work as well as detail studies and reports on the more important oil fields. The American Institute of Mining Engineers has taken the leading part in the publication of technical papers and offer very comprehensive programs at their district and general meetings. The next meeting of the Petroleum Division of this society will be Oct. 19 and 20 at Fort Worth, and will be primarily a symposium on air-gas lift and gas oil ratios.

It is of interest to note that while there are very few publications prior to this century on petroleum engineering problems the inventors were apparently quite busy. One of the earliest patents of which we find record is the Gunning, which is of particular interest since the general adaptation of the air-gas lift: to quote

"Gunning. Nov. 22, 1864. To cause the free flow of oil from wells without any mechanical appliances is supposed to be mainly if not wholly due to the pressure of gas within them, as their gas is always present in all oil wells in greater or less amount. I can by my invention, when the gas is insufficient in quantity or power to effect in itself or alone the result above alluded to, return it from the surface of the elevated oil and make it again subservient in assisting the oil in its passage upward, using only so much atmospheric air as may be necessary to make up any deficiency of gas."

It appears that operators and engineers were thinking of lifting and recovery problems fifty or sixty years

*Chairman, Petroleum Division, American Institute of Mining Engineers.

ago. Many other patents covering all sorts of production problems were issued prior to the opening of this century.

TO CONCLUDE this brief review of production engineering, and to bring it down to date, a summary of technical progress will be given. In my opinion engineers should not be given credit for orginating these improvements, but undoubtedly should receive credit for developing the technique and efficiency of the operations:

Use of mud laden fluid for drilling wells.

Use of gas or air for flooding sand.

Use of water for flooding sand.

Methods of coring formation while drilling.

Methods of maintaining gravity of oil on the lease and in pipe lines.

Air gas lift.

The production engineer in order to progress must work in close cooperation with the mechanical engineer. The improvements in oil field equipment of every sort has been very marked during the last decade. Rigs, boilers, gas engines, drilling engines, tanks, and every possible kind of lease and pipe-line equipment has been improved.

A modern lease at Seminole with its astounding array of compressors, its humming motors, centrifugal pumps, steel derricks, high pressure traps, gas-tight tanks, is indeed an impressive sight. It is in truth a million-dollar plant for the extraction of oil from the ground and it is sad that such a plant cannot have a longer useful life. However, from the nature of this business and the necessarily huge risks involved, all the more need for the engineer to make his equipment and installations salvagable, portable and efficient.

The non-technically trained field man with years of practical experience in the oil fields is the petroleum engineer's best friend and also his most severe critic. These men, who are actually responsible and in charge of most of the field work today, are helping the engineer and co-operating with him to a remarkable degree. They know better than anyone the difficult problems involved in the production of oil and they want and need the engineer's assistance.

Unfortunately, every engineer in the oil producing business is badly lacking in practical lease operating experience. The young engineer just out of school apparently does not care to undertake four or five years rough lease work, and it is only with this background and training that he can meet the field man on his own ground and give him real assistance.

He should work as a roustabout, gang pusher, pumper, gauger, pipeliner, helper and even perhaps driller. The evolution of the present day mine superintendent or manager is similar; he is an engineer who on a moment's notice can fill any job in the mine from mucking to operating a waughstoper.

The field of production engineering is almost untouched. Petroleum has been plentiful and new fields have continuously replaced the old ones. Some day, however, the operator will find it profitable to extract a part of the 60 per cent of the oil which is now left in the ground. This, of course, can be done at a price and the problems involved will be solved when that time comes.

One of the more pressing problems of today is the matter of cheaper drilling. The petroleum engineer, in conjunction with mechanical engineers and practical men, must and can devise machinery that will drill many times faster than our equipment of today by the use of high pressures and high speeds.

Another problem for immediate work is that of the use of gas which occurs with oil, and how to use it most efficiently and effectively, both as a lifting agent and an expelling agent for the oil from the sand. It is thought that much more research work should be undertaken and large sums of money set aside for experimentation on problems of this kind.

Such work as that done by the standardization committees of the American Petroleum Institute are of great value to the industry, but they should not stop there. At this time leaders of the industry are discussing conservation by the restriction of gas flow from oil wells, but as yet the engineers have no data on this problem to present to the industry.

Experimentation is badly needed and must precede legislation or chaos will follow.

Engineering, as broadly defined, is a profession dealing with facts and figures. A steel beam of certain dimensions has a certain well-known and definite strength; but petroleum production engineering is in a sense more difficult. It is impossible for the petroleum engineer to see what happens at the seat of operations.

For example, he does not know what pressure exists in the oil sand, nor the viscosity of the fluid he is trying to handle, nor its temperature. He does not understand the nature or effect of water pressure in oil wells. Many of these questions can be solved by research work and increasing knowledge will permit more logical production methods. But the fascination of problems involving maximum recovery at minimum cost will always exist.

With wells from 4000 feet to 6000 feet deep the engineer or operator really cannot put himself "within a mile" of his operation. That mile must be spanned by imagination and ingenuity.

Standardization of Buildings

By R. D. Snodgrass*

THE early history of the oil industry is a story of constant progress in the development and standardization of machinery and oil storage equipment. But the development of buildings for the housing of men and equipment proceeded at a very slow pace.

As is true in any new enterprise, those interested devoted all of their energy to the rapid and economical production of the product. Buildings were thought of merely as necessary shelters, and were seldom designed with an eye to efficiency and utility. Anything with four walls and a roof served the purpose and the realization that building equipment plays an important part in securing maximum economy and efficiency in the production and marketing of oil products is of comparatively recent birth.

Buildings for the oil industry must very definitely meet certain fixed requirements. Because of the unusual fire hazard, noncombustible materials should be used in the construction, which should be standardized for adaptation to all types of buildings including warehouses, bunk houses, pump houses, power houses and offices.

During the drilling and flush production period a great many buildings are needed, while later, when the normal production period begins, many of them can be dispensed with. Consequently, the ideal structure, is one that includes with the above mentioned properties, portability. And finally, the buildings must be made of materials which resist the corrosive action of the ever-present sulfur in oil and oil gases.

SUMMARIZING, then, buildings for the oil industry must be fireproof, standardized, corrosion-proof, and portable.

It would be difficult to go to any of the larger oil fields without encountering hundreds of such buildings. Made of heavy gauge steel sheets and structural steel supports they are incombustible; being fabricated from copper alloy steel they present the highest known resistance to sulfur and other corrosive influences present in the oil fields; consisting of specially formed steel panels for both side walls and roofs they may be taken down and reerected in other localities without loss of materials; and being of stand-

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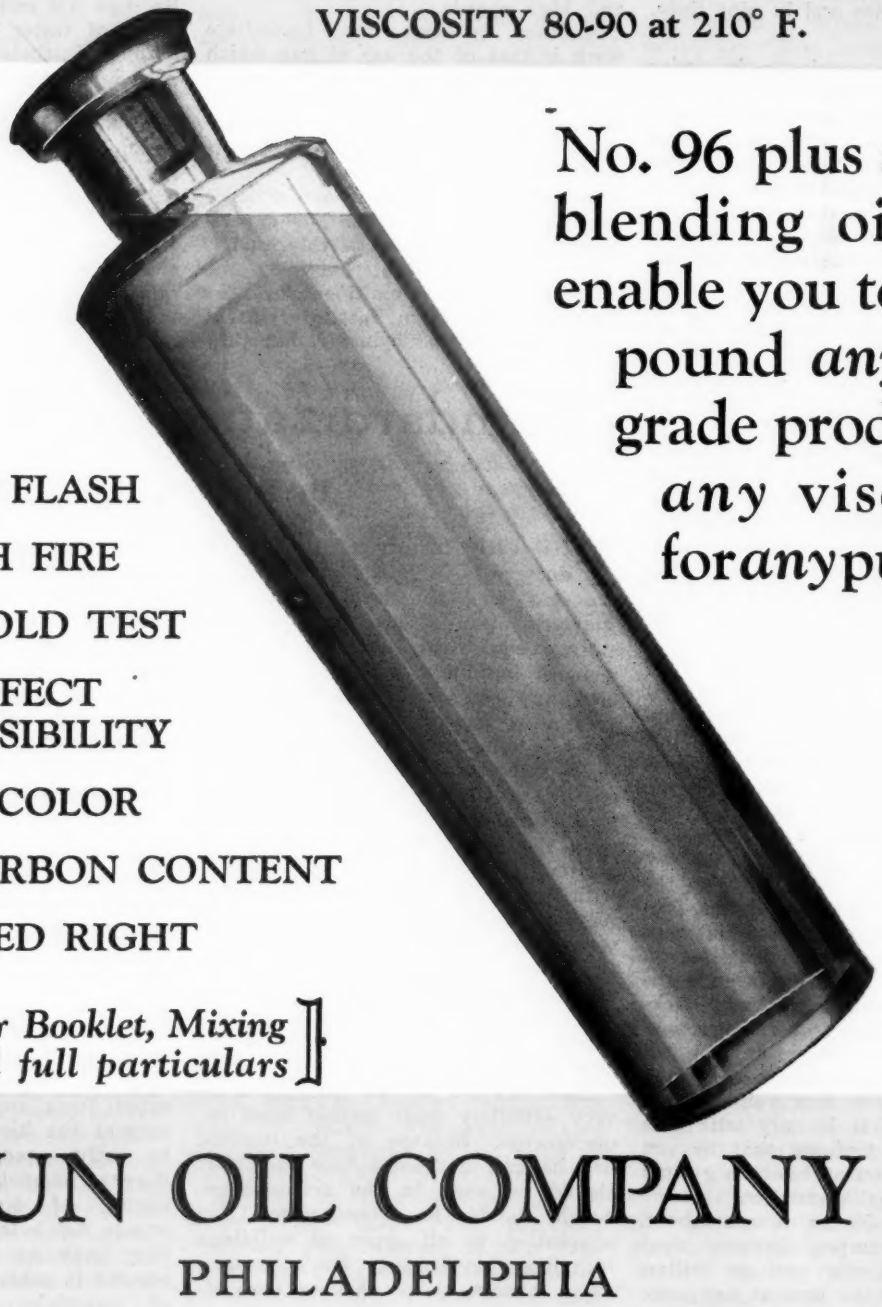

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ardized construction they represent the maximum in economy and versatility.

It has been estimated that our national annual loss due to corrosion of iron and steel amounts to more than 8 million dollars, constituting an economic waste hardly surpassed by any other single cause. Of this bill, the oil industry has been obliged to stand a large proportion. Ordinary iron and steel corrodes with incredible rapidity in the presence of petroleum products. The usual preventives applied are paint and metallic coatings but neither of these have proved themselves effective.

It was discovered however that a small percentage of copper, added to steel, especially in the presence of manganese, produces an alloy with a high resistance to corrosion of any description and that this alloy is especially effective in resisting corrosion produced by sulphur and similar agencies common to oil production and refining. So effective is this resistance that many of our leading railroads are specifying copper alloy steel for use in all places where corrosion resistance is important. Car bodies, especially coal cars, are being built of this steel. The sulfur content in coal has been a cause of enormous loss in railway cars. Copper alloy steel is changing this condition materially. Buildings manufactured throughout from a special alloy steel designed to produce the highest possible corrosion resistance, are ideal for the petroleum industry and are being used extensively.

THE use of standardized buildings is by no means confined to the oil fields. There are innumerable structures around refineries where the principal of standardization is valuable. Filling stations are also developed on this principle. When a size and type of building has once been determined upon to meet any given requirements no further expense is necessary. The design having once been determined, the cost of drawings and structural design is saved on all additional buildings. It becomes merely a matter of ordering a sufficient quantity of standard parts to build the structure.

Economy is secured because every member used is manufactured in quantity by equipment especially designed for quantity production.

Flexibility is obtained because the standard parts are so designed that they may be assembled in structures varying in height, width and length by small increments.

Speedy delivery is made possible because the standard parts are kept in stock.

Yet in providing for complete standardization, the questions of light, ventilation, insulation and adaptation to special manufacturing problems have not been neglected.

The supporting frames are of structural steel on which the expense of detail drawings, shop templates, and other operations which are usually performed for each individual piece and charged to it are distributed over many thousands of pieces.

The heavy gauge copper-bearing wall panels are of constant size but vary from solid steel to those composed entirely of sash. These panels day be combined to produce as much or as little light and ventilation as required.

The roofs also are of standardized panels of several varieties. One of these is intended to provide the minimum first cost where inside temperature and condensation problems do not enter. Other types are for structures where the temperature and moisture in the air must be maintained without appreciable variation and where complete air changes must be accomplished with extreme rapidity.

These standard buildings are so developed that they apply as economically to the smallest 1-car garage as they do to the largest manufacturing building.

Control of Oil and Gas Wells

By Alf G. Heggem*

FROM the beginning of the petroleum industry as a commercial enterprise the dominating factor has been to drill a hole to tap the oil reservoir and bring the oil to the surface. The controlling of the flow was generally left to chance with the general idea that after the oil was brought to the surface it could be reduced to possession somehow.

This was never entirely satisfactory and led to considerable waste both above and below the ground. The handling of the oil above the ground became secondary to the bringing of the oil to the surface so that the first methods employed to control the well were those which would prevent underground waste and losses.

The natural methods employed were to insert a permanent wall in the drill hole which would prevent caving and intrusion of water. Various types of casing were used but at the present time wrought iron or steel casing with screw threads is almost exclusively used with some form of shoe on the bottom which will make a tight joint and prevent water intrusion.

Where the formations are not sufficiently solid to make a good joint with a casing shoe it has been the practice to set some form of packer which generally consists of a hollow rubber or fabric cylinder mounted on the outside of a suitable piece of steel pipe in such a manner that the weight of the casing expands the packing to contact tightly with the surrounding drill hole wall.

WHERE the formations are not sufficiently solid to support the casing through packing, the wall itself must be built up by the use of cement and a number of methods are employed whereby the cement is placed between the casing and the wall of the drill hole. In all events, however, the result is to form a close fitting solid wall outside of the casing sufficient to not only support the casing but to prevent the intrusion of upper water.

With the protection of the wall of the drill hole by casing the dangers of underground losses are minimized and perhaps entirely eliminated. The next step is to prevent waste at the surface, which waste constitutes not only a loss of property but, also a serious hazard to human life. A great many devices have been developed for controlling the well at the surface. The most common being a casing head, which, as its name implies, is a pipe fitting which it attached to the top of the casing and provides means for closing in the well while permitting the oil to flow through lead lines connected to the head. This device, though, in general use, did not overcome the hazards encountered in flowing wells and did not provide a quick means for shutting in a well and it became the practice on large wells to use a gate valve which was placed on the casing below the casing head so that the well could be entirely shut in.

THIS was only a partial safeguard for the reason that the gate valve could not be closed while the tools were in the well and because of its nature it required too long a time to close the valve after the tools had been withdrawn. What was needed was a quick closing device which could be put on the well and close in the well entirely, or close the top opening and allow the oil to flow into tankage at the will of the operator.

This device was so designed that the well could be closed in while the tools were in the hole, provision being made by a suitable notch which would fit around the drilling line and the construction of the device was such that it would force the line into this notch when the valve was closed.

Because this device enabled the

*President, Oil Well Improvements Co.

operator to control the well absolutely it was known as the control casing head. This control casing head combines the features of a casing head with those of a gate valve with the added advantage of fewer fittings and quick action. With experience gained in the use of the control casing head there came modifications and improvements so that the latest type now in use consists of a head having a top connection to receive an oil saver or sand line cap, and this connection consists of a recess shoulder upon which the top fitting rests and is secured by set screws radially arranged which, being screwed in, ride on a bevelled flange on the oil saver or sand line cap and force the latter into a tight contact with a suitable packing ring disposed on the recess shoulder.

Sometimes in place of the set screws a quick acting clamping device is used which, by a turning motion of a ring throws a set of tapered lugs over the bottom flange of the oil saver forcing the latter onto the shoulder.

This device while more complicated and expensive than the set screws, is stronger and almost instantaneous in action and is especially desirable where a quick connection means prevention of waste of oil. Below the top there is fitted a cylindrical rotary valve which slides beween two seats, one inside and one outside of the valve. This provides a double seal and also gives more bearing surface to protect the valve from undue wear in action, which also provides a virtually smooth internal bore that facilitates the passage of swab or underreamer. The valve can be turned readily to close the top opening allowing the well to flow through side outlet or, in the event of accident to the flow tank, or where it is desirable to shut off the flow of oil for any reason, the valve may be turned to close the bottom opening and shut in the well entirely.

A FURTHER feature of a modern control casing head consists of a by-pass connection whereby a 3-inch opening is made below the lower valve seat, so that in the event of the valve being closed to shut in the well the pressure may be reduced by opening the bypass and thus permit the ready opening of the main valve which would otherwise fit so tightly to its seat that it would be difficult to open by ordinary means.

This bypass opening has a number of uses such as enabling a steam connection to be made thereto so that in the event of a lightning storm steam may be introduced through the head into the flow line going with the oil into the flow tank reducing fire hazard and without the necessity of shutting in the well.

Also where it is desired to kill a gas well by means of mud laden fluid a mud connection may be made through the bypass and mud laden fluid can be kept running into the well during drilling operations and thus enable the drilling of gas sands without the waste of gas, and also hold back heaving quicksands, and plastering up the wall of the drill hole below the bottom of the casing. This bypass connection also is especially suitable for a flow line connection where it is desirable to flow against a back pressure and reducing nipples or "beans" may be placed in this auxiliary flow line without interfering with the ordinary fittings on the well.

DURING drilling operations it is necessary to have a drilling cable passing through the casing head and a common means for preventing waste of oil around the drilling cable is a stuffing box known as an oil saver. This consists of a device with a flanged base suitable to being received into the top of the control casing head and attached thereto by suitable set screws or latch and carrying a packing chamber filled with some form of packing material, preferably rubber, and means for forcing the packing into contact with the drilling line to compensate for wear.

The modern type of oil saver adjusts the packing to the line from the side instead of from the top, thus the length of packing surface on the line is not altered and the full efficiency of the packing is utilized until the packing itself is worn out. The action of the drilling line is to swing from side to side, first putting pressure on one side of the oil saver and next on the opposite side. This side motion causes excessive wear on the packing material as well as on the line itself, and to overcome this and to secure a straight line motion the modern oil saver has been fitted with roller guides whereby the line is caused to travel in a straight vertical line through the packing. These roller guides have given rise to the name "roller oil saver."

With different formations producing oil and dependent upon the volume of oil, gravity, viscosity, gas and water in oil sand the method of controlling the flow of a well varies and various devices are used to meet the conditions encountered. In some wells an open flow with minimum back pressure is desired and to accomplish this the general practice is, where the volume is too great for the ordinary 6⅝-inch flow line, to place a tee on the side outlet of the control casing head and connect two or more flow lines from the head of the the well to the flow tank. In some instances as many as eight 6⅝-inch flow lines are used to relieve the pressure before the oil enters the tank. Another extreme condition is where a well produces best under back pressure, in which case a steel nipple, generally made out of a solid bar of steel about 6 inches long and threaded to fit 2 or 3-inch pipe, is placed in the flow line. This nipple is pierced with a hole varying from sometimes as small as one quarter inch in diameter up to 1½ or 2 inches in diameter. A number of wells have shown best results when flowing through a nipple having five-eights or three-quarter inch bore.

This nipple or, as it is commonly called, a "bean" permits the flow of a surprisingly large amount of oil and there have been instances where by reducing the size of the bore in the "bean" the actual production of the well has been increased.

There are no rules known which would indicate the size bean to use and this must be, with the present knowledge, purely a matter of experiment. The governing idea being that a suitable back pressure will prevent bottom water from coming into the well and also where the producing sand is unconsolidated it prevents the sand coming in and filling the casing. The thing to be determined by experiment is the size of the bean to use which will give the maximum of production, hold back bottom water and prevent the sanding up of the well.

With modern equipment there is no need of waste of either gas or oil. A flowing well may be cased or tubed without loss of oil and, in fact, the proportion of waste at the present time is extremely small compared to that of barely 10 years ago. Controlling devices of recent design have made this possible and back of it all is a sound fact. One cannot possess that which he does not control.

RACINE, Wis.—J. J. Hilt, who has been with the Racine Radiator Co., and its predecessor, the Perfex Radiator Co. since 1919, became sales manager for the Young Radiator Co. here on Aug. 20.

The company is specializing in heavy duty radiators. Mr. Hilt has had long experience in this particular field and has been associated with F. M. Young, president of the Young Radiator Co., in the above companies as Mr. Young's assistant.

NEW YORK, Sept. 17.—H. I. Grandgerard, who has been in oil export business for the past 10 years in Europe, is now assistant export manager of the Tide Water Oil Sales Corp., with headquarters here.

Mr. Grandgerard has handled virtually all phases of oil export work and has been with The Texas Co., the Union Petroleum Co. and the Acewood Petroleum Export Corp. With the latter corporation he was vice president and European representative with headquarters at Paris.

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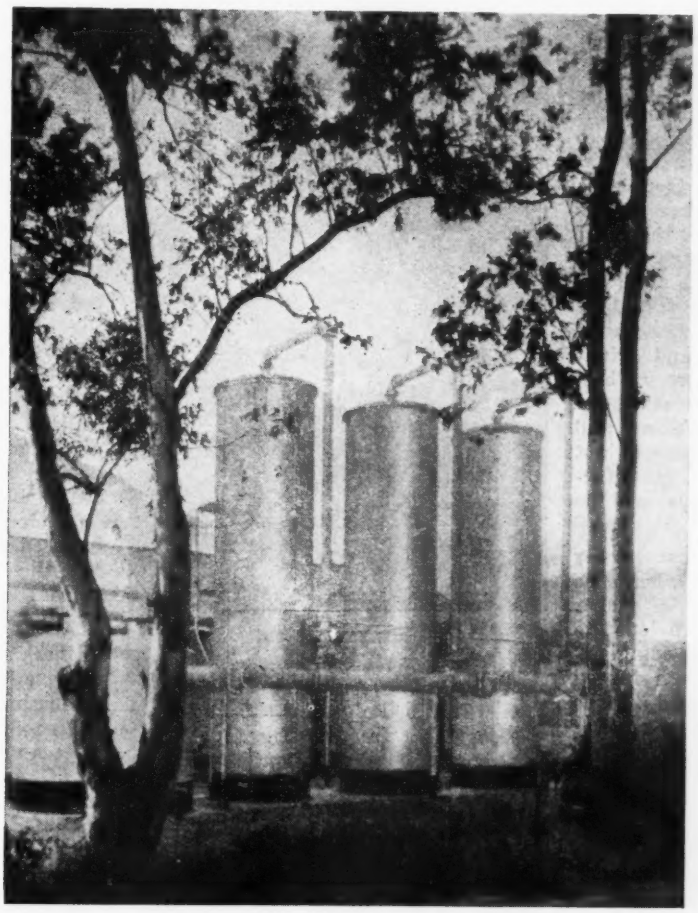

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Manufacturers, Field Men Cooperating For Longer Lived Sucker Rods

By Dudley R. Dale

ALL oil producers are more or or less troubled with the breaking of sucker rods and the consequent loss of production due to shutdown of well and the added expense thereto. That this trouble is not always due to the sucker rod is not generally considered, but the facts determined after many years of investigation have proven this to be true. Notwithstanding the fact that sucker rods are now being made with manufacturing methods and limit tolerances equaling the very best shop methods and using the most suitable material, they are breaking and will continue to break for reasons not within the control of the manufacturer. Many of the reasons will be taken up in detail later.

The history of the first iron sucker rod dates back to 1892, when the late S. M. Jones invented a sucker rod of this material. Previous to 1892, rods were made of octagonal pieces of ash or hickory, with forged iron boxes and pins strapped to the wooden rods by rivets. These wooden rods were an endless cause of trouble, due to the loosening of the rivets and subsequent failure of the rods. The large diameter of wooden rods was also objectionable, due to its occupying too much of the tubing cross sectional area and leaving too little of this area for the fluid. The wood rod would also swell and sometimes stick in the tubing.

S. M. Jones being a practical oil man and a producer, saw that the wooden rod would never do, and brought out the first iron sucker rod. This rod was made of half-inch black iron pipe whose ends were upset into cast malleable iron boxes and coupled with a malleable iron double pin coupling. This rod had a tensile strength of about 9000 pounds, failure taking place when the upset pipe ends pulled through the box ends.

This rod while not entirely successful, overcame most of the troubles common to the wood rod with none of its disadvantages. The diameter was very much smaller and the lack of buoyancy allowed free sinking in the fluid. This made far better pumping conditions and reduced the power necessary to pump a well.

THE next improvement was made by making the rod of solid iron and upsetting the ends into cast malleable iron box and pin castings. This improvement eliminated the double pin coupling, and being very much stronger could be universally used in all wells at that time. Many prejudiced opinions, however, had to be overcome before it came into universal use. Many of the operators at that time said that the new rod would cut the oil. After proving that these rods would do all that was claimed for them, they soon grew into popularity. These iron rods had a tensile strength of about 40,000 pounds per square inch and worked very satisfactorily in wells up to 1000 to 1300 feet in depth.

At about this time the manufacture of steel was fast superseding the puddling of iron and costs of same were about equal. Steel of about .15 to .20 carbon was then substituted for the iron which increased the strength at no added cost. This steel had a strength of about 60,000-65,000 pounds per square inch and was very satisfactory in wells up to 1500 feet in depth. The improvement of sucker rod manufacture parallels very much the improvement of car axles for railroad cars. As in sucker rods the first car axles were made of iron, and as speeds and loads increased axles failed. As these speeds and loads were further increased it became necessary to get stronger and stronger axles which would stand up to the duty imposed, until today they are using axles of high grade alloy steels for the most severe conditions,—the same being true for sucker rods.

About 1918, the demand for crude oil became so great that operators and drillers were hard pressed—not only to maintain existing production but to increase same. This condition led to many abuses of pumping equipment, notably of sucker rods, which has taken much of the time of the manufacturers ever since in educational efforts to remedy. This effort, while fruitful in results has not entirely eliminated all the abuses.

To overcome this abuse, and to improve pumping conditions is the constant aim of sucker rod manufacturers, and many of them maintain costly research laboratories and field personnel for such purpose. This research work has been responsible for many of the improvements made in both the manufacture and use of pumping equipment, and has been the source of much education to both the manufacturer and the oil producer.

THE sucker rod in use today is a high grade product, the result of the research work in the field and laboratory, and with the better usage, it is receiving, is performing well the work intended. The best rods are made in the upset box and pin type and the upset double pin type with steel couplings, each having advantages according to service into which they are placed, the merits of which will be discussed later.

Among the major improvements made in sucker rod design. the following may be mentioned: Better fitting threads, proper proportion of pin diameter to rod diameter, and im-

DUDLEY R. DALE

Mr. Dale after graduating from the Toledo Polytechnic School in 1907, was first employed in the engineering department of the Pope Motor Co. engaged principally in tools, heat treating and laboratory testing. Leaving this company, he was next employed in the engineering department of The Owens Bottle Machine Co. as designer. He then associated himself with The S. M. Jones Co., where he was assistant superintendent for four years, and was then made chief engineer, spending much of his time in the oil fields studying field conditions.

He is a member of the American Petroleum Institute and was a member of the special committee on sucker rod threads, whose deliberations resulted in the standard A.P.I. sucker rod joint.

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THE Guiberson Corporation appreciates the great work the A. P. I. Standardization Committees are doing to effect savings both to the manufacturers and to the users of oil field equipment. The Guiberson plant is equipped with gauges, dies and taps made to A. P. I. standards.

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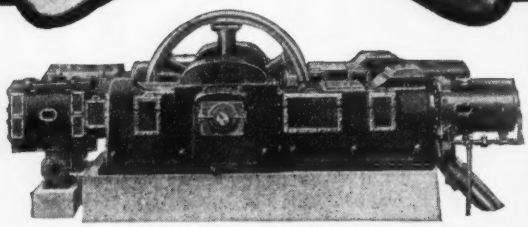
BESSEMER



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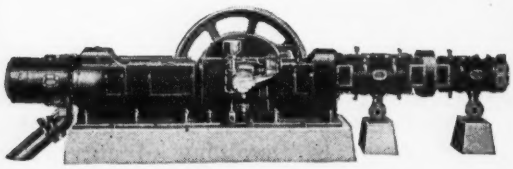

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For two stage work where a single cylinder unit will suffice, a Bessemer tandem is the ideal compressor.

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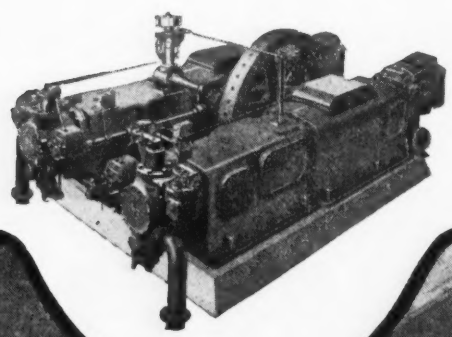
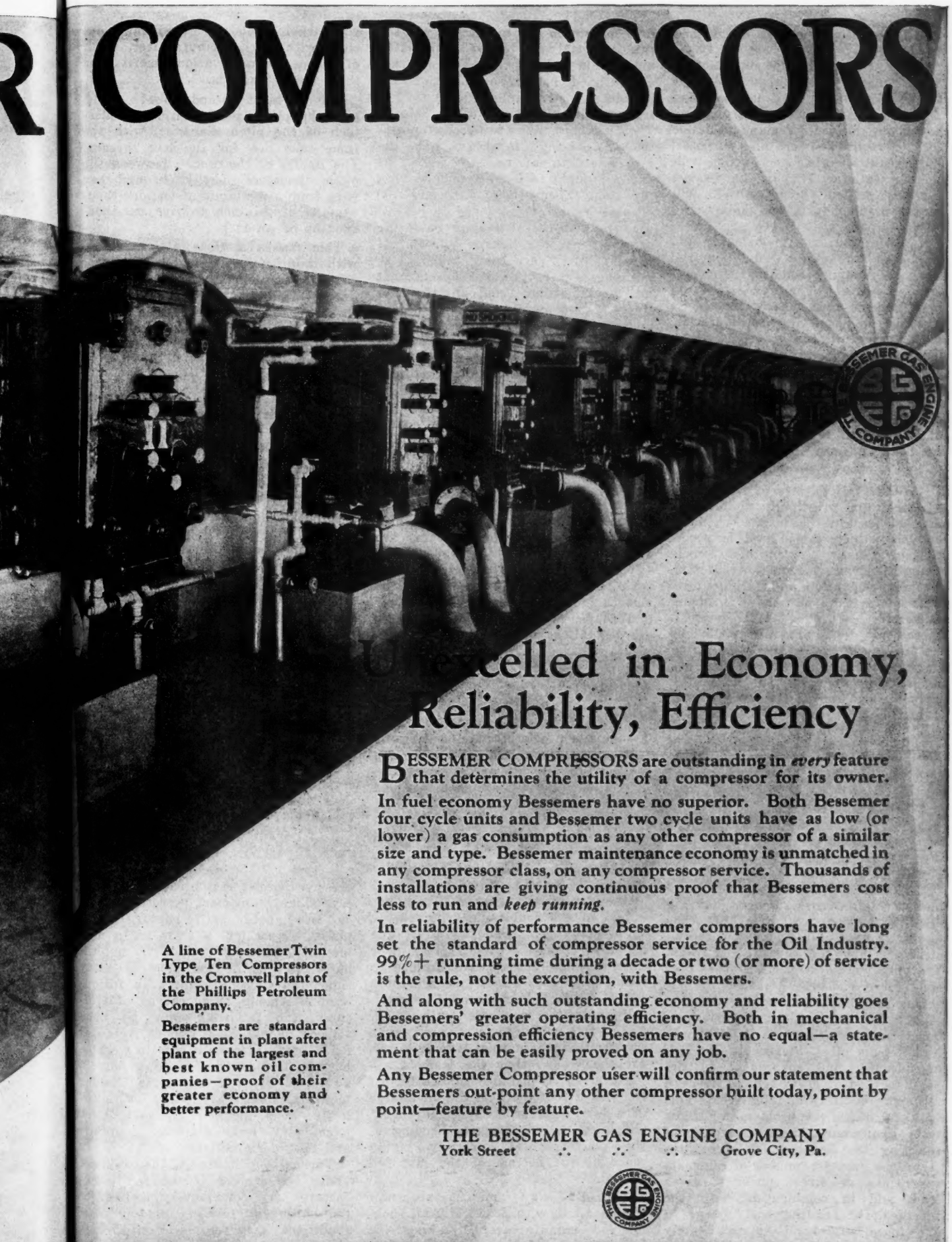


COMPRESSORS



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In fuel economy Bessemers have no superior. Both Bessemer four cycle units and Bessemer two cycle units have as low (or lower) a gas consumption as any other compressor of a similar size and type. Bessemer maintenance economy is unmatched in any compressor class, on any compressor service. Thousands of installations are giving continuous proof that Bessemers cost less to run and *keep running.*

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A line of Bessemer Twin Type Ten Compressors in the Cromwell plant of the Phillips Petroleum Company.

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proved inspection methods of finished product.

The steel used in their manufacture has undoubtedly been given the most study, chiefly because it is the heart of the rod. Conditions varying as they do in the wells demand that one steel be suitable for all purposes. This means that a steel which will function satisfactorily in the deepest and most difficult pumping wells will work satisfactorily in the shallow and easy pumping wells.

A manufacturer cannot make, and supply stores cannot handle a rod for each pumping condition, for economic reasons. Therefore, the rod manufacturer must take the maximum pumping conditions into consideration, and after calculating his loads, static, dynamic and inertia, as near as possible, select a steel accordingly. After this selection he must make many field and laboratory tests before placing his rod upon the market. For after all, the actual test of the rod is in the field and not in the laboratory.

LABORATORY tests of sucker rod steel are principally confined to physical results, although chemical analysis is determined and is necessary. Elastic strength, tensile strength, per cent reduction of area, per cent elongation and fatigue tests are made for the purpose of insuring uniformity of steel mill product. Microscopic tests are also made for the purpose of noting the grain structure and cleanliness, dirt in steel being one of the principal causes of early sucker rod failure when steel is loaded with same.

In the selection of a proper sucker rod steel the following requirements are essential: High elastic strength with ductility, and high resistance to fatigue. The percentage elongation and percentage reduction in area are measures of the ductility and toughness, and as a general rule are inversely proportional to the tensile strength.

For example, hardened tool steels have a high tensile strength but the ductility is very low. On the other hand, wrought iron has a low tensile strength, but the ductility is high. The problem of selecting the best steel for a sucker rod is one of balancing or proportioning the relation of strength to ductility, it sometimes becoming necessary to sacrifice a high tensile steel, because of its lack of ductility and consequent brittleness, for one of lower tensile strength and more ductility or toughness. This is a metallurgical problem. Fatigue tests are made for the purpose of selecting that steel which will withstand the greatest number of alternate repetitions of stress under a given load, and in combination with the tensile tests are the best means of knowing beforehand approximately what a rod will do in the well.

In the manufacture of rods, the first operation is inspection of the raw material as received from the mill. This includes the physical tests, as outlined before, examination for roundness, straightness, absence of rolling mill kinks and other defects. They are then taken to pyrometer controlled heating furnaces and the proper length of rod to make the upset, brought to forging temperature, this temperature being around 2200 degrees Fahr.

In progressive stages of gathering or upsetting, the box or pin end of rod is forged, care being taken to so design these progressive upsets that no "buckling" or "cold shutting" of the stock takes place. This forging operation leaves the forged end of steel in a stressed condition and in order to remove the stress, the ends of rods are placed in a normalizing furnace and heated to a temperature of about 1600 degrees Fahr.

This operation refines the coarse grain due to forging operations, and puts steel in best condition for machining the ends. After inspection they are taken to the threading machines where the ends are accurately machined. In the inspection which follows, the following points are rigidly adhered to:

The pin end must be in alignment with body of rod. Threads must be smooth and of proper pitch, diameter and shape, and within the tolerances allowed. Box ends must be in alignment with rod, of proper pitch diameter as tested with "go" and "no go" gages, and of proper depth.

IF RODS pass the inspection they are given a protective coating of rust preventive and a metal cap fastened to pin end and a paper cap placed in box end to protect threaded ends against injury due to handling and the weather. They are then bundled, 100 feet to the bundle, and shipped.

Sucker rod failures are principally of two types, pin breaks and rod breaks, with an occasional coupling failure of the double pin type rod.

Pin breakage is almost entirely due to three causes: Offset pins, poor thread design and fit, and failure to shoulder joints. Offset pins are those which are forged or threaded eccentrically with the remainder of rod. A pin in this condition is stressed much greater than the normal load produces, for the reason that the load is applied a short distance off center of the rod, giving the load the advantage of a lever arm or bending movement, which results in alternate bending of the pin, fracture generally taking place at the bottom of the last full thread.

Thread design and fit are now standardized, with practically all sucker rod manufacturers, making the same design of threads. Heretofore pin dimensions and style of thread was largely a matter of individual design with each manufacturer, each of whom claimed various merits for their own standards.

The present standardized A.P.I. pin thread is made with a tolerinch of the pitch diameter, with the same tolerance for the box threads. The limits, or clearances, between the pitch diameters of the pin and box vary from a minimum of one one-thousandths of an inch to five one-thousandths of an inch.

This makes a close fitting thread with minimum play, and does not cause any trouble in the field in making up readily. Heretofore many of the operators required free fitting threads, which no doubt, saved some time in making up a rod string, over the time required to make up, a string of tight fitting rods.

The loose fitting threads, however, have a tendency to unscrew and thus parting the rod line. It is an easy matter to make a loose fitting thread, but accurate machine work and very close inspection is required to make interchangeable close fitting threads.

A sucker rod pin should not shake in the box. If it does, there is too much play, and the shouldering of joint when first made up is only temporary. The whipping and snapping of the pumping motion soon loosens the shoulder, and places all of the work upon the pin alone. This results in early fatigue of the pin.

Most of the rod breaks occur at the beginning of the upset portion of rod, or close thereto. All of these breaks are of the type known as "fatigue" or progressive fracture type, erroneously called "crystallization". This fracture is generally coarse or crystalline for about one half of the area and smooth or velvety for the remainder.

TO OBTAIN a fracture of this type, it is necessary that progressive transverse breaking of the crystalline grain mass proceed at more or less speed until rupture takes place. A scratch, a seam, or a nonmetallic inclusion or dirt, in the outer surface of the steel is many times the starting point of a fatigue break. Among other causes of fractures, the following may be mentioned: Kinks and bends, crooked holes, small area ball seats in working barrels, tight fitting working barrels, sanded barrels, careless fishing methods, wells that pump off, overheated steel, incipient cracks in steel, offset pins, large diameter couplings and heat demarcations.

Various conditions of the well not under the control of the rod manufacturer are contributary causes for rod abuse and failure. Among these conditions may be mentioned, high pumping speeds in conjunction with short strokes and poor condition of

pumping equipment. Kinks and bends are the result of careless handling from the time of shipment to their placement in the well. Dropping of the rods in well also results in a kinked string.

These kinks generally take place at or near the beginning of the upset or joint portion of rod. As the joint is the most rigid portion of the rod, the kinks naturally take place at this point. The subsequent pumping action, with its alternate loading, concentrates at the kink, with the result that a hinging action takes place. A rod, once it has received a permanent set or bend in a cold condition, is immediately on the way to rupture. This is due to the fact that the various crystal or grain aggregates composing the steel have been removed from a position of stability to a strained unstable condition which only needs time and continued application of stress to complete breakage.

JUST how much rod breakage is due to crooked holes is problematical, but it is reasonable to believe that rods receive a bending action in passing a curve in the tubing as many of them show much wear at both the joint and center portion. The flexing action certainly stresses the joint to a greater or lesser extent.

Small area ball seats for working barrel valves cause rod kinking due to the resistance offered fluid in passing through the traveling valve on down stroke of pump. Also a certain amount of pounding takes place when the volumetric efficiency of barrel is low due to the small area of standing valve and pressure of gas. This same pounding takes place when production in well is so low that they are pumped for a short time periodically or "pumped off". Valves, of as large area as possible to install, offer less fluid resistance and therefore less flexing of rods on down stroke, and should be used.

Tight fitting plungers in certain types of pumps are the cause of much rod trouble. Where the resistance or friction of the plunger is great, the stroke at plunger is not the same as at the polish rod, with the result that the loss of such stroke has to be taken care of by compressing the rods. A sinker bar on top of plunger, if practically made, would aid in driving the plunger rapidly through the fluid and eliminate some loss of stroke. Sanding up of barrels and lead lines in certain fields is another source of rod trouble, the action in this case causing both tension and compression on the rod.

Rod crews can do much to eliminate trouble and increase life of sucker rods by careful work at the well. Rods are often pulled two and three joints at a pull, and where a rod hanger is not used, the rods must be

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laid on walk. In placing the rods on walk, they are pulled under some of the lower derrick girts. This often results in a short kink, generally near the joint, one or more places in the rod and invariably results in a broken rod.

IN FISHING for broken rods, the socket being placed on lower end of fishing string is dropped upon the top of broken rod with the result that both strings are often kinked. This is no doubt the quickest and easfest method but is harmful to the rods.

Shouldering of joints is necessary and very important. A joint not properly shouldered throws all the stress upon the pin. There is always a slight amount of clearance between the mating male and female threads which causes a minute movement to take place. A tight shoulder takes up this small play and prevents motion between the joints.

A drilling crew would not think of making up a dirty tool joint, but sucker rod joints are often run, with shoulders and threads encased in dirt and forced together with large Stillson wrenches. Pins are often started for destruction in this manner. Long stroke with fewer strokes per minute and a dwell or stop at each end of stroke is ideal for pumping and sucker rod life.

The dwell at each end of stroke allows the rod string to come to rest before the reversal of motion takes place with the result that joints are not so highly stressed and all portions of rod string are moving in the same direction at any instant. Reversal of direction is therefore easy and inertia loads are at a minimum. The action of the standard short stroke, fast pumping rig is exactly the reverse. Rod strings are snapped and whipped, reversal of direction of the top rod taking place at a different instant than that of the bottom rod, with inertia loads at their maximum.

FAULTY material or good material improperly handled in the fabrication, is the cause of some rod failures. Steel that is seamy, dirty or rolled out of round should be classed as defective material. The rods received from the steel mills should be finish rolled at the proper temperature and straightened. The analysis and physical tests should come within the limits specified, any received not coming within the specifications should be rejected.

In the operations following the acceptance of good steel, the heating is perhaps the most important and is the source of some failures. Steel can be easily overheated and even burned. Proper temperature control in connection with first class furnace design and good men watching the heating, prevent burning and over-

heating. The furnace atmosphere or "heat" should be adjusted to get what is known as reducing conditions, to eliminate scaling or oxidizing of the steel.

A fire burning with an excess of air or oxygen causes an excess of scale. The fire therefore should be adjusted so as to use a little more fuel than there is oxygen in the induced air to cause complete combustion. This is known as a "reducing" flame.

The surface of high or medium carbon steels when heated is more or less decarbonized according to the furnace atmospheric conditions and the time it is in the heat, therefore in sucker rod manufacture, the heating for the upsetting operations is of prime importance.

THERE is just one other place that rods may break, this is at the so called place of demarcation. The rods, in being upset or forged, are heated for a length of 12 to 15 inches. At a certain place in the heated portion of the rod, the temperature is at what is known as the critical range. This means, that at that place, a new grain structure is being formed which reaches its minimum size, where the upper critical temperature, or highest temperature of the critical range, takes place. This exact temperature varies with the carbon in the steel.

In other words, the structure of the steel as rolled, in passing through the critical range of temperature, is wiped out and a new structure created, when the upper critical temperature is reached. This new structure is more or less like the structure of the unheated portion of the rod, depending upon the temperature at which the rod was when the rolling was completed.

The two structures being different, therefore, make a somewhat vague line of heat demarcation, the effect of which as far as rod breakage is concerned is problematical, varying according to the difference between the finished rolling temperature and the finished forging temperature.

A normalizing heat treatment after the upsetting operations, neutralizes the effect of a heat demarcation, relieves forging strains, and places material in most suitable condition for the machine work to follow. In certain classes of steels, this normalizing treatment is the equivalent of a quench and tempering operation as followed in the heat treatment of carbon steels. This is particularly true for that class known as high manganese steels, which have been introduced by one sucker rod manufacturer with remarkable success.

At the present time, sucker rods are made of two standard designs, the double pin and the box and pin types. Freak designs have often

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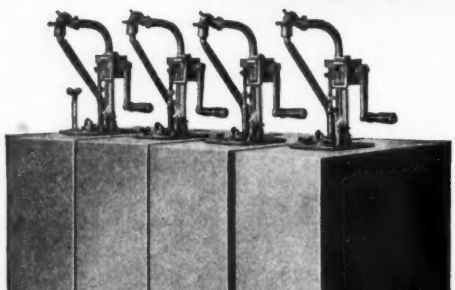

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been placed upon the market with variable success. The male and female threaded and shouldered joint remains the standard, because of its simplicity, ease of manufacture and reliability.

THE double pin type of rod with enlarged diameter coupling was brought out for the purpose of taking care of the wear in the joint, especially in crooked holes. The coupling, being a separate piece was easily and cheaply replaced, where in the box and pin rod, any wear in the box, meant scrapping the rod. The objection, however, is in the fact that a double pin rod has twice the number of pins of the box and pin rod, pins being the greatest source of rod failure.

Another objection to the double pin rod is the length of coupling required. The shorter the joint, the better the rod, for the reason that when compression takes place in a string of rods, a long joint makes a longer chord or flat spot, with consequent greater angle or bend taking place where upset portion of rod starts. The curve to a string of rods in compression should approach a true arc, with the flat spots or chords of the stiff joints, as short as possible.

The box and pin type joint is the shortest possible design to make, where a wrench square and threaded connection is included.

In conclusion, many improvements have been made in the field in handling rods. Field men have realized that all of the rod failures are not due to the rod alone, but many times are local, and they are making efforts to improve field conditions. Improved elevators, rod hangers and pumping motions are helping the operator to cut his shut down losses by eliminating much abuse.

The rod manufacturer is working now and has been working for many years to make his rods better, and with proper co-operation in the field, the future should show far less loss of production for the operator caused by sucker rod failure.

Hope Will Build 320-Mile Line

MT. VERNON, O.—A contract for the construction of one of the largest pipe lines in its history has just been awarded to the Hope Engineering & Supply Co., with headquarters.

The line will be laid for the Dixie Pipe Line Co., and will extend from the Waskom field in eastern Texas to Livingston, from which point trunk lines will lead to Houston and Port Arthur. It will be 320 miles long, the largest in Texas, according to the Hope company.

More than three-fourths of the pipe will have electrically welded seams, and will be the first of its kind to be used in a natural gas transmission system, the company states.

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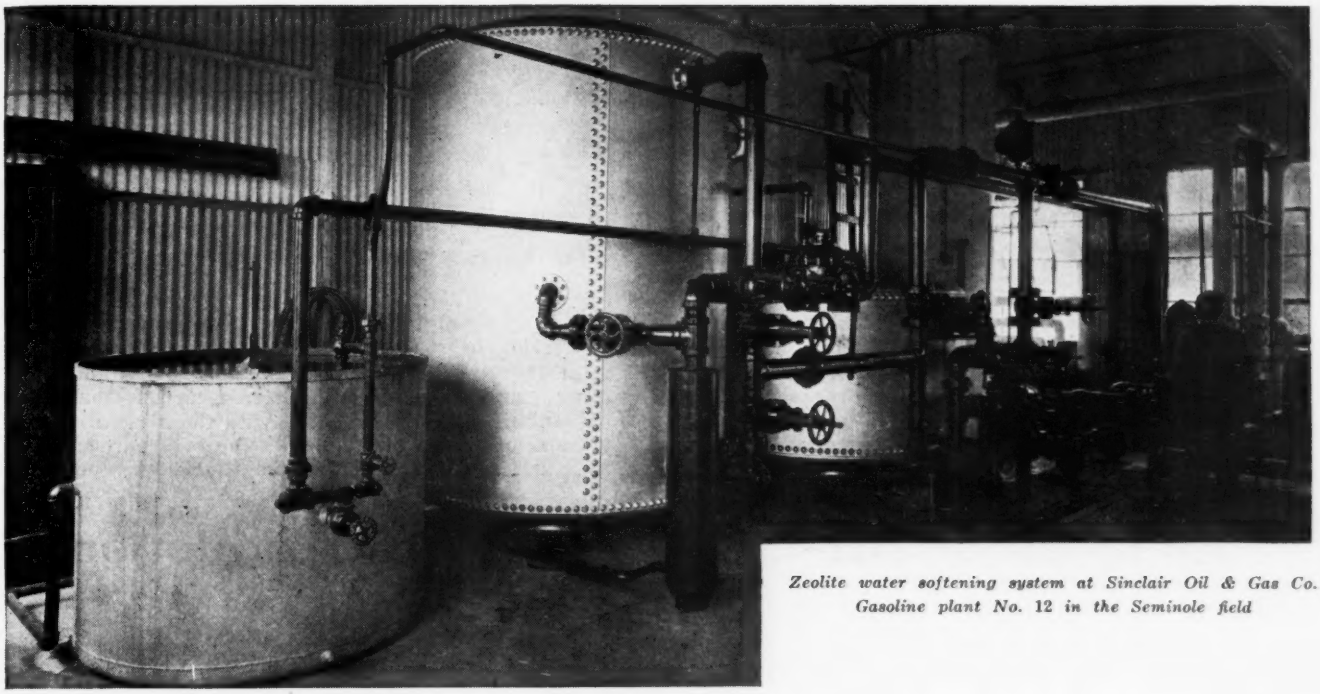

Zeolite water softening system at Sinclair Oil & Gas Co. Gasoline plant No. 12 in the Seminole field

Zeolite Water Softening Treatment

By Robert M. Moore *

PROPER and efficient handling of water, whether it be purifying, softening or filtering, in the oil field is a matter of major importance and the development and progress of water softening in recent years is very interesting.

Many papers have been published lately about treating the water with chemicals to neutralize the hard salts to make the water fit for boiler, engine and condensing use, so that scaling or corrosion would not take place, but very little has been said about the one method, the zeolite softening, which has now become so popular, practical and economical wherever it can be used.

Every engineer, whether he be connected with the oil industry or other lines, knows the disadvantages of hard water which, if could be eliminated, would be one of the best investments in the entire plant and one of the cheapest and best insurance policies against shut-downs. Many of the disadvantages caused by hard water in the oil industry are lower boiler capacity, lower cooling efficiency, priming, foaming, corrosion, pipe and flue replacement, loss of time from shut-downs, expense of chemicals for cleaning out boilers and engines, and the lessened life of boilers or engines.

The method of softening hard water by zeolite water softeners was first started by the oil companies about three years ago.

The name zeolite, as it is used today, applies to all the members of the group of "base exchange silicates" that are used in the water softening art. There are many zeolites on the market, but the chemical base exchange reaction which takes place in softening water, and in regenerating the exhausted silicates, is always the same, no matter what other characteristics they may possess.

Zeolite softeners are used to remove from water the lime and magnesia which causes scale to form in steam boilers, in the cooling jackets of gas engines, or in lines with which it comes in contact.

The lime and magnesia are always present in combination with one or another of several acids by which it is neutralized. Lime and magnesia as well as sodium (caustic) are bases and combine with common acids to give the salts commonly found in water.

When the bases and acids react they give neutral salts which do not have the properties of the original substances. Thus as shown, sodium or caustic lye will unite with hydrochloric acid to form sodium chloride, which is ordinary table salt.

If lime and sulfuric acid react, calcium sulfate or gypsum result.

Bases		Acids		Salts
Calcium (Lime)	+	Carbonic	=	Calcium carbonate
Magnesium	+	Sulfuric	=	Magnesium sulfate
Sodium (Caustic)	+	Hydrochloric	=	Sodium Chloride

These facts have been pointed out to make it plain that the nature of a salt as to its scale forming properties is determined by only part of its makeup. Thus, calcium carbonate will form scale but sodium carbonoate will not, although both have carbonic acid present. The character of a salt as regards its scale forming character is determined by the base present.

ZEOLITES are known as base exchange substances. They do not remove salts entirely from the water but exchange the base present for one of different character. The zeolite itself may be regarded as a base (calcium, magnesia, or sodium) in combination with a complex acid. Thus we may have sodium zeolite, calcium zeolite, etc.

When water containing calcium carbonate flows through a bed of sodium zeolite, the bases are exchanged. The zeolite takes up calcium and holds it and gives up sodium, so that the water no longer contains calcium carbonate but has sodium carbonate in it instead.

In a similar manner sodium zeolite will take up calcium or magnesia from other salts dissolved in water and leave sodium in their place. The sodium salts do not form scale.

There is a limit to the amount of calcium and magnesia which a zeolite bed will take up. When that limit is reached the bed is washed with a

*District sales manager, Paige & Jones Chemical Co.

Softening Reactions

Salts Causing Hardness		Softening Agents		Sodium Salts in Treated Water		Exhausted Zeolite
Calcium carbonate $CaCO_3$	+	sodium zeolite Na_2Z	=	sodium carbonate Na_2CO_3	+	calcium zeolite CaZ
Calcium sulphate $GaSO_4$	+	sodium zeolite Na_2Z	=	sodium sulphate Na_2SO_4	+	calcium zeolite CaZ
Calcium chloride $CaCl_2$	+	sodium zeolite Na_2Z	=	sodium chloride Na_2Cl_2	+	calcium zeolite CaZ
Magnesium carbonate /$NgCo_3$	+	sodium zeolite Na_2Z	=	sodium carbonate Na_2CO_2	+	magnesium zeolite /NgZ
Magnesium sulphate /$NgSO_4$	+	sodium zeolite Na_2Z	=	sodium sulphate Na_2SO_4	+	magnesium zeolite MgZ
Magnesium chloride /$NgCl_2$	+	sodium zeolite Na_2Z	=	sodium chloride Na_2Cl_2	+	magnesium zeolite MgZ

strong solution of salt, or sodium chloride. A reverse action occurs in which the bed gives up its calcium and magnesium and becomes again a sodium zeolite.

The salt solution is changed to a calcium and magnesium chloride solution which is washed from the bed to the sewer. This washing process is what is called re-conditioning or regenerating in the operation of a zeolite softener.

Some zeolite softened waters which are high in bicarbonate result in high caustic alkalinity in the boiler, and makes the engineer very skeptical about installing a zeolite system for fear of embrittlement of the boiler steel. Today, however, it has been proven that with such waters the addition of a certain quantity of inhibiting sulfate ions off-sets such a condition. The addition of acid (sulfuric) to the zeolite-treated water serves to liberate an equivalent amount of carbon dioxide, and if the water passes through a de-aerator before going to the boiler, the free carbon dioxide is removed along with the oxygen. Also, in such cases, some of the remaining bicarbonates are thus broken up.

Principles of Air-Gas Lift in Oil Production

By D. K. Hutchcraft*

FLOWING of oil wells by air or gas is not a new process. It has been used for a number of years both here and abroad. For several years even before 1914, many oil fields in Russia have employed this method of producing oil. The air lift has also been used frequently in this country where large volumes of water have been encountered. However this method has not been used generally by the oil industry in the Mid-Continent until within the last few months.

Having had a number of years experience with the air lift method of flowing water, and knowing the various advantages of air lift over plunger type pumps, when I came to Tulsa five years ago I soon saw the many advantages the air or gas lift would have in pumping oil. However I was unable to sell the idea to the producers that I approached on the subject inasmuch as they were able to produce oil by swabbing and the use of the plunger type pump without excessive maintenance. This was due to the fact that most of the oil wells were comparatively shallow.

It took three years for my dreams to come true and that happened because the Tonkawa field started to quit flowing naturally. It was soon found that the old method of swabbing or pumping was becoming very expensive as these wells were deep. Consequently more rod trouble was caused as well as excessive maintenance on swabbing equipment. I renewed my efforts trying to interest several of the producers in this field in trying out the air or gas lift system. I finally sold the idea to a producer and he agreed to try it. However he was very skeptical and it was finally arranged to loan him the necessary equipment to make a test. To my knowledge this was the first application of the air lift principle in the Mid-Continent field where it was installed in a well making 100 per cent. Since this first installation, approximately two years ago, the air lift or gas lift has become one of the principal methods of producing oil in the Mid-Continent field, not only in deep wells but in comparatively shallow wells.

There are many theories prevalent pertaining to the gas lift at this time which conflict with the principles of the air lift as applied to water. My conclusions are that every principle involved in the water lift is found in the gas lift; both follow the laws governing wells flowing naturally. The main difference between flowing water and oil is the presence of gas in the oil well which assists flowing and the necessity in a water lift to have high efficiency as water sells for only a few cents a barrel. It is necessary for this efficiency to maintain a high submergence. But in flowing oil the cost per barrel is much greater, hence operating costs of maximum efficiency are not as important and much lower submergence can be used.

THE principles of air or gas lift I divide into three parts. First comes the air or gas lift where submergence is the main factor. This principle corresponds to a well flowing naturally with normal oil gas ratio. In this division every principle involved in the water lift as generally used is found in the gas lift. This holds true so long as the working pressure is reasonably high, so that it is not necessary to depend on velocity. In this type of installation the highest efficiency can be obtained and the oil gas ratio will be the lowest for the particular well.

This condition usually is found in flush fields where the oil gas ratio is low. Seminole is a very good example of these conditions, it being comparatively easy to make an installation. The efficiency is at its maximum, requiring very little engineering skill to make an installation that is satisfactory regardless of whether the producer has used every precaution in designing his plant to obtain the highest efficiency and the greatest economy of operation.

IN MY opinion the operation and maintenance costs can be materially reduced by using a standard direct connected gas engine driven compressor. Under this classification the most efficient installation is where the velocity is held down to a minimum. The normal capacity of a gas lift can be obtained by the following formula:

$$C = \frac{P \times 2.31}{L + Y} \times AC_1$$

C is normal capacity; P is absolute pressure in pounds (at the nozzle of the footpiece); L is length of discharge pipe from point air or gas is injected in the bottom of the well or from the nozzle of the footpiece, to point of discharge; Y is back pressure in feet, referring to water; A is area of discharge; C_1 is the constant depending on the gravity of the fluid being lifted.

It has been found advantageous in some cases to pinch in the discharge which is generally termed holding back pressure on the gas lift, but by the properly designed installation, no back pressure will be required, consequently a much higher over all efficiency can be obtained. In a number of instances where sheet water has been encountered below the oil sand, it has been found that by putting in the tubing at the bottom of the well, the water increases materially, owing to the coning effect. This has been overcome to a great extent in a number of instances by raising the tubing.

Inasmuch as the normal capacity is increased or decreased according

*Clark Bros. Co.

in air lift service

Chapman Valves at Amerada Petroleum Co., Bowlegs, Okla., an air lift well.

Chapman

Chapman Gate Valves of Chrome Nickel Steel are ideal for air- and gas-lift service—for the very qualities which have made them selected equipment wherever the oil industry demands reliable valves. Chapman Chrome Nickel Steel is an electric furnace product, is stronger than forged steel, and the valves pass tests which allow the highest factor of safety over the most extreme conditions of oil field service.

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Valves

to the working pressure, it will be found that by properly designing the flow lines so that the producer can take advantage of the maximum operating pressure, the same results will be obtained as far as back pressure or differential of pressure is concerned, and the number of barrels per day will remain constant regardless of the location of the tubing, but with a greater efficiency. Consequently a lower cost per barrel can be obtained by changing the tubing to the proper size. The back pressure will vary as the total number of barrels per day vary.

Better results will be gained, when the tubing is located as low in the well as possible, generally just above the oil sand. The results obtained will be a lower oil gas ratio, less horsepower per barrel lifted even though the working pressure may be materially increased. Great care should be taken in designing an air or gas lift plant. All compressors, pipes, and fittings should be designed with a conservative factor of safety so that the operator can avoid accidents which are bound to occur unless great care is taken.

SEMINOLE is now passing from the first principle to the second principle involved, the velocity lift where the actual working pressure or submergence is so low that it requires very high velocity. This principle is similar to a well making a great deal of gas and spraying oil naturally. In this case it is readily seen that the amount of gas or air required to lift a barrel of oil will be high and consequently the efficiency low. An installation of this type is justifiable where the proper care in designing the compression plant has been used to obtain the lowest cost possible per million feet of gas compressed. It eliminates the excessive maintenance found in trying to pump wells, especially deep ones, with the plunger type pump. In many instances the efficiency has been greatly increased where these conditions exist by flowing by heads. This changes the principle back to the one involved in the first division until the head is blown off and the air or gas starts to break through.

The third principle involves the use of a combination displacement and gas lift, where the well is operated intermittently. The design of this installation calls for the proper size flow line with the properly designed orifice in it above the oil level so that sufficient pressure may be obtained on the fluid in the well to force it up to the discharge pipe where it is mixed with the air or gas passing through the orifice. This type of installation has been used very successfully, modifications being made to meet well conditions.

Nothing is needed in a well where the sand is tight with the exception of a properly designed discharge. However where loose sand is encountered it is necessary to have a suitable chamber surrounding the discharge pipe with the properly designed foot valve for the oil to enter. This of course is an intermittent flow design, it being perfected by I. S. Dunn who has put in a number of this type installation, especially in West Virginia and in Pennsylvania.

There has been much discussion of the relative advantages of using air or residue gas. It is my personal opinion that residue gas should be used at all times possible, there being practically no corrosive effect when residue gas is used unless air is present in this gas. Whereas when air is used frequently a good deal of trouble is caused by corrosion, especially when water is present.

There have been several instances reported where the production per 1,000 feet of air was much greater than when residue gas was used. These results were obtained from the same well in one instance. Using the same number of cubic feet of gas as air, the production was reduced almost one-half. However from data obtained from other wells the difference if any was so slight as not to be noticeable. The use of the air or gas lift has been very extensive in scope in the greater Seminole district. On Aug. 25, 1927 there were 730 producing wells, producing approximately 437,226 barrels of oil that day, of which 337 wells were flowing by the air or gas lift method, 107 were flowing naturally, 120 on the pump, 80 on the swab, 65 not producing. It is my opinion that without gas lift, production would not have exceeded 275,000 barrels.

IN SUMMING up the many advantages of using compressed air or gas in the production of oil, I feel that within a short time the oil fraternity will as a whole recognize that it is one of the principal factors in oil production, that when a new field has been brought in the operator will design his plant so that he can continue to operate it with the maximum efficiency during each period above mentioned; that he will bear in mind the application of air or gas being put back into the sand. This will be done as soon as the rock pressure has diminished to a point where it is practical to start restoring the pressure. Several of the larger producers in the Seminole pool are taking steps at the present time to carry out a similar program. In fact one of the major companies in buying original air or gas lift installations for Seminole had this in mind.

It is my opinion that most of the direct connected gas engine driven compressors in Seminole will be used for restoring the pressure in a large part of that field inasmuch as the lowest operating cost possible including power cost is obtained by this type of unit. A number of the operators have previously put in installations for restoring pressure on the sand to increase production, whereas in Seminole this application would be to maintain a reasonably high production.

Trade Volume Picks Up: Prices are Higher

Sept. 17—RANGER WASHINGTON, Sept. 17.—The dollar volume of trade in the week ended Sept. 10, as seen from figures on check payments, was greater than in either the preceding week or the corresponding week of 1926, according to the Department of Commerce. Wholesale prices continued to average higher, as compared with the preceding week but were still below the level of last year. Prices of cotton continued to advance. Iron and steel prices, showing no change from the preceding week, averaged lower than a year ago.

Loans and discounts of Federal reserve member banks were higher than a year ago. Prices of stocks listed on the New York Stock Exchange showed little change from the previous week but were substantially higher than in the corresponding week of 1926. Interest rates on call loans averaged higher than in the previous week but were lower than in the same week of last year. Bond prices showed no change from the preceding week but were higher than in the corresponding week of a year ago. Interest rates on time money, showing no change from the previous week, averaged substantially lower than in the same week but was higher than a year ago. Business failures were less numerous than in the preceding week but were higher than in the same week a year ago.

The production of bituminous coal in the week ended Sept. 3 was larger than in the previous week, but smaller than in the same week of last year. The output of lumber during the same week was larger than in either the preceding week or the corresponding week of 1926. The production of beehive coke declined from both the previous week and the same week of last year.

Receipts of wheat at primary markets were greater than a year ago. Cattle receipts on the other hand were smaller. Receipts of hogs showed a slight increase over a year ago.

Mann-Freel Incorporate

HOUSTON, Sept. 15.—The Mann-Freel Co., Inc., has been formed at San Angelo with capital stock of $10,000 to drill oil wells and own oil and gas leases. Incorporators are B. C. Mann, president; Dan Freel, vice president; John D. H. Tester, secretary-treasurer. Offices are maintained in the St. Angelus hotel.

The Evolution of the Pumping Power

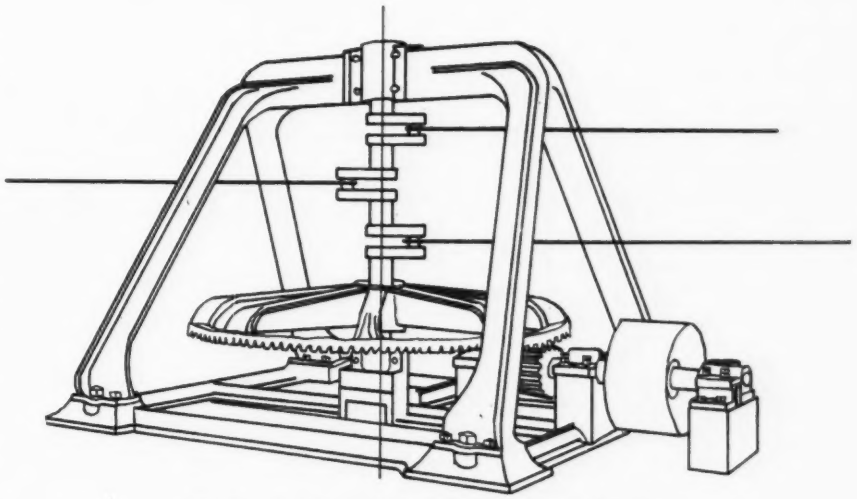
By O. C. Staples*

THE evolution of the pumping power by which two or more wells are pumped by the use of one central prime mover is a matter that once more gives special and particular emphasis to the old adage that necessity is the mother of invention. In the process of this evolution, rather as a fruit of it, we see a clean and distinct indication that the invention and application of efficient central pumping powers has salvaged the petroleum industry by making for an economy of operation that has made it a profitable operation to pump oil wells producing less than a quarter of a barrel of oil a day.

The first artesian oil wells were drilled in Pennsylvania and as the production curve showed a sharp decline, producers faced the necessity of abandoning small wells or producing oil at a distinct loss. Obviously the proper solution of the problem was to find a more ecomonical method of operating aside from the system of pumping each well with a steam engine and boiler on the site. Natural gas was seldom available in quantities large enough to generate a steady head of steam in the boilers; boiler wood was a steady fuel expense and coal entirely too costly.

Some unknown genius conceived the idea that it might be possible and practicable to pump two wells by one engine. It was a radical idea but to put it into practice was only a simple matter of attaching to the bandwheel another crank arm aside from the one which was attached to the pitman of the walking beam. From this extra crank arm, placed opposite to the other, ran a wooden shackle to a crude form of pumping jack of the V-type and made of hewn timbers. This worked excellently so long as the two wells were in a direct line; but an angular deviation made an application impossible.

THE next mechanical principle used involved the use of two opposite cranks one one band wheel connected by wooden shackle rods to a horizontal turntable that alternately rocked back and forth. Atop this turntable were wrist pins on which the shackle lines were attached, these shackles being wooden rod lines swung to V-type wooden pumping jacks. The rod-line lengths were united by means of iron straps. During hot or dry weather the breakage was considerable and the average pumper was a very busy individual mending rod lines. The turntable type of power was to a reasonable extent fairly efficient; however, it very frequently required attention as the wooden keying or bracing demanded much care and not infrequently the entire structure would be pulled out of line or totally wrecked.



Bevel gear and vertical crank pumping equipment

Crude as this type of installation was, it clearly established a fundamental out of which grew the "push-and-pull" type of power.

The oil fraternity substituted a master gear and pinion to a steel shaft with a proper gear reduction and on this steel shaft was mounted two cranks at opposite throws which rocked an iron disc back and forth and this developed the stroke to pump the wells attached. Later the addition of a second disc made is possible to pump more wells adequately balanced. And is was then that the modern "push-and-pull" power came into existence.

THE first disc pumping power to be placed on the market was built in Franklin, Pa., in the late eighties by one George Allen. Again we have necessity mothering invention. Allen was something of a capitalist and an inventive genius. A serious fire destroyed two of his principal holdings: a refinery and a number of small producing wells. His associates voted to rebuild the refinery but decided, because of the small production of the wells, not to pump them again if such operations involved the purchase and installation of a steam engine, a boiler, band wheel, and walking beam equipment at each well. Allen, faced by this situation, invented the metal disc geared power using a series of eccentrics. Initial field trials convinced Allen that this type of power was far superior to anything then on the market and oil producers agreed with him. He manufactured this type of eccentric to sell at a remarkably low price and for many years other manufacturers in the field were forced to pay him a royalty on his patents, although they were briskly contested.

A NEW manufacturer at this time appeared on the scene, one Yates, who produced a power consisting of a geared arrangement where an upright shaft with a series of crank throws attempted to supply a mechanical principle that would compete with the disc or eccentric type of power fully covered by the Allen patents. The Yates type of power attained some degree of popularity but it was never as smooth or efficient a unit as the Allen type.

The bevel gear and eccentric powers of the present day are similar in construction to the bevel-geared disc type, except that eccentrics, instead of crank and disc, are used on the vertieal gear shaft to impart motion to the shackle lines. As a rule they are made with one, two or three eccentrics according to the number of wells to be pumped; two eccentrics are generally placed 180 degrees apart and three eccentrics 120 degrees apart to give a balanced load. When the eccentrics are placed on the shaft above the gear wheel, the power is termed an overpull type; the reverse is called an underpull type. In some overpull types the eccentrics are between the gear wheel and the top of the frame; in some they are an ex-

*Frick-Reid Supply Co.

tension of the shaft above the top of the frame. Deviations exist in the placing of eccentrics in proportion to the number of manufacturers in the field, each advancing reasons for their choice.

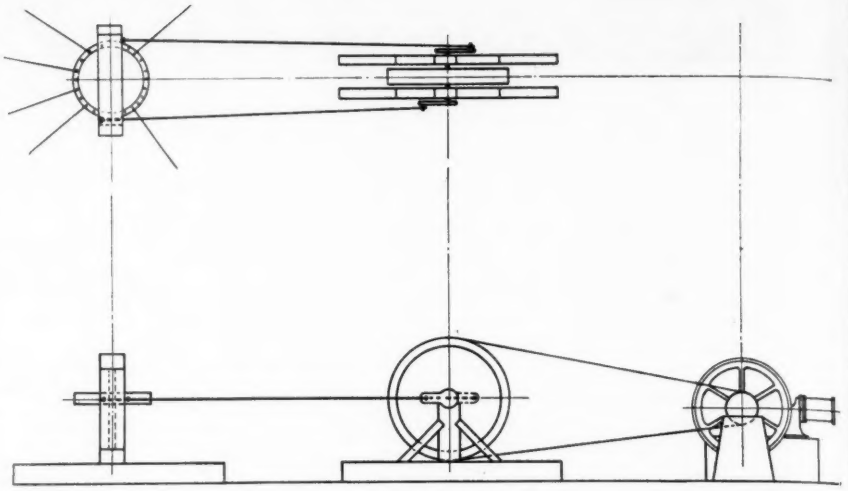
Following the Allen and Yates types of powers the band wheel power came into being; this involved the use of a horizontal wooden band wheel with eccentric applied above the bandwheel to a metal shaft and equipped with suitable bearings. This was known as the original band wheel power which was manufactured for years and which was used (as are all band wheel powers) with a belt idler to divert the belt from the engine pulley to the horizontal band wheel. In this application it will be noted that the eccentric idea was still maintained, proving the soundness of the Allen patents.

Production moved west to the Mid-Continental fields where level country prevailed and the manufacturing fraternity serving the oil industry deemed it necessary to lower the shackle line load centers; consequently the manufacturers came out with the underpull band wheel power with the eccentrics under the band wheel. As this development was going on a steel wheel supplanted the wooden type. Today the steel band wheel is a standard commodity.

ORIGINAL power installations were designed to handle shallow wells. As the years have passed the depths of oil fields has been steadily increasing; to the natural increased pumping loadage caused by this increased depth has been added something in the nature of an additional hazard: rotary drilling prevails on most deep wells and rotary holes are normally crooked holes. These two factors naturally throw a greater load-burden on the type of power being used. As power requirements have increased owing to the above conditions and to extra loadage of fluid handled there has been a corresponding capacity and ability made available by gas and oil engine manufacturers and the manufacturers of powers. Today it is possible to obtain pumping powers capable of handling production to a depth of 3,500 feet through 2-inch tubing.

Recently an installation has been made of a band wheel power weighing 18,000 pounds to handle 9 wells over 3,000 feet deep being pumped through 3-inch tubing; this power will be driven by internal combustion prime movers.

Keeping step with the capacity, ability, and efficiency of the powers and prime movers, other equipment has been designed, engineered and perfected to handle greater loadage. Pull rods have been increased from ⅜-inch to 1-inch in diameter; shackle connections of drop forgings are now commonly used because of their capacity to stand shock and loadage. Development of clamps, turnbuckles and disconnecting hooks has likewise kept pace and are now drop forged and provided with safety devices. Belts have increased in efficiency and to a width of 22 inches.



Type of disk pumping power

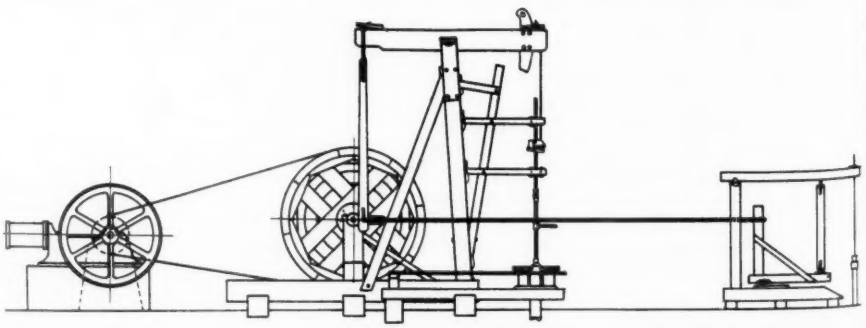
GAS and oil engines are now used on approximately 97 per cent of all power installations because of their proven reliability and specific economy and long life. The horse power of these prime movers is steadily increasing and the latest installation employs an engine of 100 h. p.

In installing these plants there is a great variation of ideas among producing companies; in some instances the engine is connectel direct to the power; others use the countershaft between the engine and power; again, others install the countershaft in the opposite end of the power house from the power with the engine in the center of the house. Recent installations of countershafts are mounted on anti-friction bearings.

Safety operation of connecting and disconnecting knock-off posts is now general and these devices have been improved to a point where the operator works without hazard.

One of the major improvements in grouping pumping methods is in the types of modern jacks being used. Certain of these jacks embody the ability to lengthen the stroke of individual wells to 60 inches if necessary. Latest jacks also embody the feature of straight lift which eleminates stuffing box leakage always hitherto a source of trouble. Latest types of jacks weigh 2,500 pounds and all moving parts are equipped with interchangeable bronze bushings running in a constant oil bath.

AS I LOOK back over a period of over a quarter of a century I am amazed at the changes that have taken place in the mechanics of group pumping from a central prime mover. Today's equipment: gas, oil or gasoline engine prime movers, various types of powers, shackle lines and equipment, pumping jacks is about as near perfect, I believe as posible. Certainly every item, every mechanical feature is a monument to the practical knowledge and the engineering supervision behind them. Regardless of what the future of our production horizon may be, I am confident that pumping equipment will keep pace with operating conditions, producing units properly and adequately engineered.



Another pumping power hookup

DYERSBURG, Tenn.—A modern service station was completed and opened for business on Aug. 6 here and is operating as "Guy's 711". It is owned by Guy Jester.

Cars with Dependable ROTARY PUMPS

Modern Blackmer Unloading Units are furnished with gasoline engine or electric motor drive in various capacities from 5 to 500 g. p. m.

You can unload an 8000 gallon tank car in 20 minutes or 3½ hours —whichever you prefer.

The new Blackmer O. J. unit which has been designed especially for oil jobbers, has two 100 g. p. m. pumps. Either pump will unload the average tank car in less than 1 hour and 45 minutes.

This new unit is furnished with either gasoline engine or electric motor drive. It has a separate clutch for each pump. Ports are so designed that both come on the outside which greatly simplifies piping.

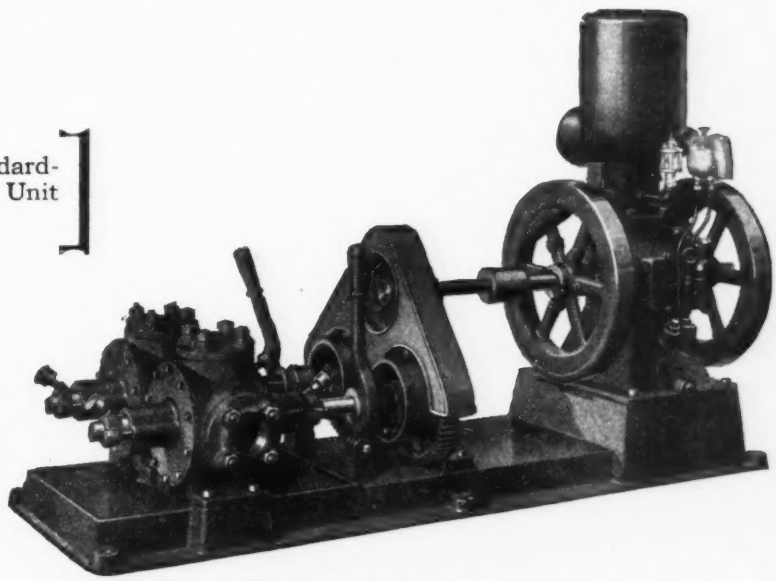
Gears are cut semi-steel with bronze bushings. Pinion is of bakelite impregnated fabric, which insures long life and quiet operation. The entire gear assembly is completely enclosed with a heavy guard.

When handling hazardous liquids and it is desirable to separate the motive power from the pumps, we furnish the new O. J. unit with an extended base which permits the building of a brick firewall between the power and the pumps. When specified, this type of unit will be furnished at no additional cost.

[Because of increased production and standardization of design, this new Blackmer O. J. Unit sells at a substantially reduced price.]

Ask for information and prices.

Consult our engineering department on your bulk station plans.



The new Blackmer Oil Jobbers unit with gasoline engine power and extended base to permit the building of a brick firewall between the power and the pumps.

PUMP COMPANY
Grand Rapids, Michigan

Air and Gas Compressing For Flowing Oil and Placing Pressure on the Oil Sand

By E. W. Jordan

ONLY in recent years have the world's oil producers come to realize the very important role the compressor is destined to play in the production of crude oil and its products.

Previous to the last score of years the compressor was unknown as an oil producing medium, and there were very few manufacturers who pretended to build compressing machinery on a large scale; those that were built were designed principally for the purpose of gathering gas at a low pressure and raising it to a higher pressure to force it to market through long pipe lines, or for use as blowing engines in large iron and steel mills, also a few ammonia compressors and like services.

We believe that we are safe in making the statement that the combined capacity of all of the compressors built in the United States within the 50 years prior to 1910 would not equal the capacity of those built and moved into the gas and oil fields in the last 10 or 12 years.

Up to 1905 the majority of compressors were steam engine driven, only a few manufacturers at that time were turning out really reliable gas engine driven units and they were of large horse power, driving compressors of proportionate capacity. The smaller compressors were almost invariably steam or electrically driven.

At the present time all of the old manufacturers are still in business and they have, from time to time, revised their gas engines until they have developed thoroughly efficient and dependable gas engine driven compressing units. This is also true of the majority of the new firms who have entered this field within the last few years, and so many manufacturers have taken up the building of compressors that there are very few lines of endeavor where competition is more keen.

Every manufacturer who has been in the business for any length of time has found it necessary to revise or re-design his compressor cylinder, or some parts of it, more often the valves than anything else. During the days of long stroke, slow speed compressors, driven by steam engines the mushroom type of poppet valve filled the bill very nicely and was very efficient when properly installed. But in the later days of gas engine and short stroke, high speed steam engines it was found that they would not stand up under the increased speeds, soon pounding themselves to pieces, on account of their weight.

SO IT was found necessary to design a type of valve of lighter weight and increased strength in order to withstand the increased speed and impact. This led to the designing of valves to be made from thin steelplates, and has resulted in the multiplicity of shapes now on the market. All of them meet the requirements very creditably but they are all far from perfect, despite the fact that the various manufacturers have searched the civilized world for the best material obtainable for this purpose, and a great deal of trouble and expense results from breakage or failure of some part of the valve.

We wonder how many people aside from the designing engineer ever stop to consider the work performed by a valve during a single month's operation. A valve with 3/16-inch lift operating at 180 R. P. M. in one month travels 46 miles, receives 41,472,000 impacts, and the actuating spring, whether self-contained or separate, is flexed a like number of times, in temperatures ranging from normal atmospheric temperature to temperatures exceeding 700 degrees Fahr. It is no wonder that valves and springs become crystallized and fail.

The creating of artificial rock pressure on the oil producing sand, and the flowing of the deep wells in the Seminole pool has developed new problems for the compressor manufacturers which have been promptly met. One of the most important of these problems was getting away from the danger of serious explosions due to compressing air to extremely high pressures.

The real danger under these conditions is not generally understood by operators, neither do they understand why the temperature of air under like conditions is much higher during compression than that of natural gas. So a few words of explanation and warning might be in order and possibly save some lives and much property.

To demonstrate the difference in rise of temperature between air and gas due to compression, we will cite a few instances. At 5 compressions the rise of temperature of air is 307 degrees Fahr. And the temperature rise of gas is 210 degrees Fahr. At 10 compressions the temperature rise of air would be 496 degrees Fahr. while the rise of temperature for gas would be 324 degrees Fahr.

TO THE above temperatures is to be added the actual atmospheric temperature less 60 degrees Fahr., as, for example, if the atmospheric temperature is 105 degrees, deducting 60 degrees we have 45 degrees. 496 degrees plus 45 degrees equal 541 degrees.

Now, in designing compressors for changeable pressure conditions, the capacity and horse power requirements are usually based on the normal working conditions or the volume

E. W. JORDAN

Mr. Jordan has followed mechanical engineering 35 years, principally along the lines of compressing work. Since 1907 he has specialized in oil and gas engineering, more specifically in natural gasoline. Was among the first to take up this line of research. Was in the employ of the Peoples Natural Gas Co. and the Hope Natural Gas Co. four years—to 1911.

In 1912 took a position with the Bessemer Gas Engine Co. as gas and oil engineer.

In 1916 established an engineering office at Bartlesville and Tulsa, Okla., following construction of gasoline and compressing stations.

In the spring of 1922 returned to former position with The Bessemer Gas Engine Co., which position he still holds.

and pressure conditions at which the compressing unit will be likely to work most of the time. So, if during a short period of time this unit is required to work at a discharge pressure several times greater than the normal discharge pressure, it would be necessary to reduce the volume of air or gas handled.

This in the past has usually been done by reducing the intake pressure. This in turn unbalances the load and sets up extremely high temperature conditions in the high stage cylinder. A 165 H. P. unit compressing air from zero to 350 pounds should carry cylinders 13½-inch by 6¼-inch by 20-inch at 190 R. P. M. and deliver approximately 730,000 cubic feet of free air per 24 hours. Ordinarily, if it is necessary to increase the discharge pressure to 1000 pounds, it would be accomplished by reducing the intake pressure to 10-inch vacuum, reducing the volume of delivery to 413,000 cubic feet free air, an intermediate pressure of 35 pounds gage, ratio of compression of 5.21, a temperature rise for first stage 320 degrees Fahr. The second stage would have a ratio of 20.5, final pressure 1000 pounds the temperature rise would be 720 degrees Fahr. This is entirely too high temperature to take a chance on, as it will gasify most any ordinary gas engine oil and set up a very touchy explosive mixture. Lower temperatures have been known to cause very destructive explosions.

THE remedy for such a condition is an adjustable clearance in the compressor cylinders, which some of the older compressor builders are already incorporating in their cylinders. This not only permits the operator to balance the load and temperatures but to hold the load up to the full normal horsepower of the compressing unit at all times, and under all varying pressure conditions.

As an example of balancing the load and temperatures by using a variable clearance:

By increasing the clearance of the cylinders, the volume handled is reduced to the ability of the available horsepower to handle and still maintain zero intake, this would give an even ratio of compressions for each stage. From zero to 1000 pounds the total number of compressions is 70.5. The ratio of each stage equals the square root of 70.5 equals 8.4. This would give each stage a temperature rise of 442 degrees Fahr., although this temperature is still too high for good practice, it is not nearly so dangerous as the preceding condition, and it is advisable to use an exceedingly good grade of cylinder oil to prevent carbonizing and creating trouble with the valves.

In the matter of compressing gas, where the temperature for air is given as 320 degrees Fahr., for gas it would be 155 degrees Fahr., and where the temperature for air is stated as 720 degrees Fahr., for gas it would be 457 degrees Fahr. In the balanced load condition where the temperature rise is 442 degrees Fahr. for air, for gas it would be 289 degrees Fahr.

In the above conditions it is assumed that there is efficient cooling between stages, and all figures are based on 14.4 pounds as absolute zero pressure.

Considering the foregoing facts we most earnestly warn all users of compressors, especially where air is being compressed, to consult the compressor manufacturers' engineers before taking chances on unusual conditions.

If gas alone is being compressed, as long as the pressures are kept within the safe strength of compressor and connecting piping, there would be no liability of explosion or bad effects other than low efficiency or carbonizing of the lubricating oil, which would cause bad action of the valves. Of course, if the gas is being taken in under a vacuum, unless great care is taken with the piping connections and all packing is kept tight there is always a possibility of taking air in with the gas and creating a combustible or explosive mixture.

WE HAVE known this very thing to happen. Gas without a certain portion of atmospheric air will not burn or explode from high temperatures.

Compressing air, either single stage or two stage to excessively high pressures is an entirely different problem. If the purchasing agent supplies too low flash oil and the operator inadvertently uses too much in his compressor cylinders there is always a possibility of setting up a dangerously explosive mixture.

We do not advise compressing air to exceed seven compressions per stage, as at that number of compressions that temperature rise is 392 degrees Fahr. In single stage work this would give 85 pounds gage pressure from zero intake, in two stage work the final pressure would be 450 pounds gage. Pressures above this amount could be more efficiently and economically handled in three stages, the temperatures being kept within reasonable limits. A greater volume of air or gas would be delivered per power unit than in two stage.

We believe that every compressor manufacturer should be so equipped in the engineering department that he can furnish expert advice on any subject that may come up with his customer. We feel that this is service to which the customer is legitimately entitled, and if such service or advice is consistently followed it would save much grief and expense to both manufacturers and customers.

Installation and Operation Of Band Wheel Powers

By John Reid*

PUMPING powers for multiple pumping by the use of surface rods and jacks, coupled to the sucker rods, have been an important factor in the lifting of oil in an economical way to the surface.

These pumping powers range from simple 2-well affairs weighing less than 300 pounds to massive machinery weighing nearly 10 tons.

Power styles have narrowed until at present two kinds, push and pull and eccentric, are in general use with the eccentric style dominating the field.

In nearly all applications of eccentrics the eccentric is horizontal. The power applied rotates the eccentrics by gearing or by a band wheel lying in a horizontal position. The gear or band wheel is driven by a belt coming from the prime mover and given a quarter of a turn over an idler.

Bandwheels are built principally of steel and range in steps of 2 feet, from 14 to 24 feet in diameter with a belt face from 10 to 28 inches.

The difference in these factors gives rise to a difference in horsepower delivered and thus it is found that if one were using a 24-inch belt on a 28-inch face, the wheel being 24 feet in diameter, and were applying a stretch or tension common to the field (transmitting 1 HP in 350 feet of travel per minute per inch of belt width) 103 HP would be delivered.

The bandwheel power usually consists of a base into which an upright shaft is forced or shrunk and keyed in. In some cases base and upright are cast as one. Upon this is placed the eccentric and bandwheel hub which rotate on the shaft. The steel construction supporting the belt rim is hung to the center and bolted.

In order that the side thrust imposed upon the power may be taken up, the end of the shaft extending above the wheel is made so that strain rods may be fastened to the top of

*Joseph Reid Gas Engine Co.

the shaft and thus take up this side thrust.

ONE manufacturer of bandwheel powers rotates the shaft with the wheel and keys the eccentrics to the shaft. The ground end of the shaft runs in a bearing which is bolted to the concrete while the upper end of the shaft is held in place by a bearing fastened to the strain rods.

Due to the increasing depth of wells pumped and the demand for continuous service, generously designed bearing and constant lubrication are essential. The lubrication problem met in this particular type of field equipment is probably a little more difficult than that of any other to manufacturers of oil field equipment.

Because of the blowing sands of the southwest the power bearings should be dustproof. Again, the oil must reach the bearings in spite of extreme weather conditions—30 degrees below zero Fahr. at Bolivar, N. Y. and 110 degrees above zero Fahr. in southern Texas. While it is possible to put a partition between the engine and the power, leaving an aperture for the belt, and thus keep the engine room warm, yet because of the slots for the rod lines in the walls of the power house it is readily seen that the power is subject to all the extremes of temperature.

It is obvious that oils must be selected with a view to the geographical territory of their use with the power and consideration must also be given to the change of seasons in relation to the grade of oil used.

IT IS customary in southern New York state to burn, in winter, a low gas flame under the power and thus keep the oil fluid and in a condition to circulate.

Due to centrifugal force on the eccentric, oil is thrown over the rim of the eccentric hub if the motion of the power is too fast.

Length of stroke of power eccentrics range from 18 to 30 inches but the 20-inch stroke is popular and the one most generally used. However, it would seem that it would be good engineering to increase the length of stroke at the power instead of multiplying it at the jack. A decrease of the number of strokes at the well would give the same result, if a longer stroke were used. This would cause fewer load reversals of the fluid and would make it easier on the equipment in the well.

Wells 3000 to 3100 feet deep are now frequently pumped and the writer knows of one well of 3500 feet being pumped in multiple. The last mentioned is the extreme depth at which a well is being pumped that the writer knows of.

One is safe in saying that any well using sucker rods can be pumped in multiple where a balance or a see-saw effect can be maintained between opposite wells. The power application is only limited by the power that can be transmitted by the prime mover.

At the present time our company has built and has a customer who is using a band wheel power designed for a load of 210,000 pounds per revolution or 10 wells having a starting load of 21,000 pounds each.

In estimating for the size of a power it is necessary to have accurate data as to starting loads. The amount of fluid pumped does not always give one enough information to figure on. One rarely finds on hand in the offices of operating companies accurate information as to the fluid levels.

Also, while the gravity of the oil may be accurately given, the percentage of water has much to do with the power required to raise the fluid.

Free discharge of the raised oil to stock tanks is also vital to efficiency in pumping. Tight stuffing boxes on the polish rods, small lead lines to tanks, a number of wells discharging into too small a manifold or header—all create friction and unnecessarily consume power.

THE writer has knowledge of complaints stating that engines are not delivering their horsepower. But a careful analysis of the lead lines made it necessary to change lease conditions before success was insured for the installation.

Probably due to the fact that multiple pumping was developed in the hilly country in the vicinity of Oil City and Franklin, Pa., rough ground offers no great obstacle in developing a lease using rod lines. Judgment must be used in placing hold-ups and hold-downs. A short hold-up or hold-down will be a source of trouble in broken rods and a consumer of unnecessary power. These should be proportioned correctly.

A rule followed by one contracting company installing powers is to make a hold-up or hold-down two and a half times the length of the stroke. This is found to give good results.

Careful layout of a lease will show obstructions to be avoided or an odd well balanced by using a swing in a strategic position. A properly designed swing will bring the load to the beam at as near right angles as possible and leave it in the same manner.

MULTIPLIERS and reducers are not so essential in the surface lines as formerly, due to better jack design. The newer jacks are so designed that each well can have its stroke regulated either for its lost motion from the power or set for a proper stroke for any particular well.

Jacks properly designed so that they can be counter-balanced and give a fairly straight lift to the polish rod are a necessity in multiple or power pumping.

The vees should be of sufficient length so that the arcs through which they move shall not put an undue strain on their members. A safe rule to follow is that the distance from the saddle to the rod line shackle should be at least two and one half times the stroke of the surface lines.

Two and one half times the stroke —or a power with 24-inch stroke should have a radius of 60 inches. While this is not generally done, good practice recommends the adoption of this general rule by those engineering power installations.

Rod line supports should be accurately set for a correct line and properly spaced with attention given to the weights of surface lines.

IT IS obvious that local conditions limit the length of surface lines and, therefore, also limit the usefulness of pumping wells by the power method. However, the writer knows of one rod line just 8 feet under a mile long. The best economy of power installation will be made only after a careful survey of local conditions.

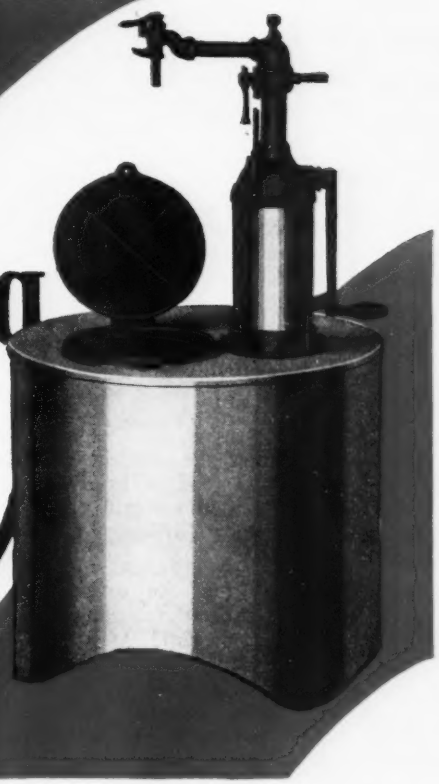
In some fields it is customary to plan and install the power before the lease is entirely developed. This is usual in fields where the initial production is not large. Where this program is followed, should the lease not be developed radially around the power, dummies may be set to balance wells which do not have other wells to off-set them.

Where wells are pumped by heads care must be taken in the installation of throw-offs so that the pumper may change wells with ease and safety. It is customary in more recent installations to run the rods through posts braced to take all the load of the well when the well is disconnected from the power. This displaces throw-off ends imbedded in the power foundation which were difficult to repair when broken.

The surface lines should have a limit stop or post placed near the well so that if the rod line should part between that point and the power, not more than two inches over the natural drop of the jack will take place. In this manner one prevents jammed jacks, bent polish rods, and, in some cases bent sucker rods. Whipping surface rods and torn rod supports are also saved.

It has been practice in the past to use single pin clevis connections on power eccentric connections. With wells 2000 feet or deeper it is best to use a connection that will extend over two or more holes on the ring and thus avoid the wear of the pin in the ring and the effect of the load concentrated on one

Big Profits in Kerosene Dispensing



No. 1140—110 Gal. Kerosene Tank Outfit—also furnished in 60 gal. capacity—No. 6040.

FRY-MARVEL PUMPS

No. 6540—65 Gal. Kerosene Tank Outfit—also obtainable in 120 gal. capacity—No. 1240.

Every branch of the business that can be made to show profits is being carefully expanded and made to produce by the alert wide-awake service station operator.

One of these sources of profit frequently overloaded is the kerosene end of your business.

But like any other part of your business, to be profitable kerosene selling must be handled in an efficient, business-like way with the right kind of time conserving, efficient equipment.

The Fry-Marvel tank units here shown are designed specifically for the economical, speedy, profit-producing handling of kerosene.

Marvel No. 405 one gallon gasoline pump shown at the right fitted for underground or basement storage tank is the last word in kerosene handling equipment.

All of these units are fitted with 1 quart, 2 quart and gallon quantity stops and will give that regular Fry-Marvel service known so well throughout the entire industry.

One of the five units in the Fry-Marvel kerosene line will fit best into the floor space at your disposal and make money for you.

Write for attractive prices and complete specifications.

No. 405—One-gallon pump.

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point. This condition is particularly bad on a new power where only one or two wells have been applied to one side. This causes a chatter and jumping which is hard on rod lines and power alike.

On leases where it is desired to have some wells deliver more fluid in a given time than another well on the same power it is customary to give these wells more stroke either at the jack or having one eccentric with more throw than the other. For this purpose eccentrics may be furnished with 20-24-inch, 20-30-inch and 24-30-inch throw.

Thus it is seen that many conditions govern economical installation of the band wheel power. Account must be taken of geographical and climatic conditions and of the local limitations within a specific territory. Accurate information of all details enumerated together with practices peculiar to a particular field are necessary to the best application of the power with economical use.

Trend in Design of Rotary Drilling Tools

By L. J. Black*

IN ORDER that the subject may be fully understood, a brief historical sketch of the origin or introduction of rotary drilling would be in order.

Rotary drilling had its origin in the days of the early development of Spindletop. The original well was drilled in 1901 for Captain J. F. Lucas by James G. and Al W. Hamil, with rotary tools. Several failures had been made before in the attempt to develop the coast country for oil and sulphur, with standard cable tools.

In a small way rotaries had been used in central and north Texas, at Corsicana, and for water well work in shallow territory. The original depth of the Spindletop field was such that the light rotary outfits of that day were sufficient to do the work, and no special development was made for several years, simply refinements in operation and manufacture.

As the depth gradually grew deeper, the rotary drilling equipment was gradually enlarged upon until today we have the present equipment, which is successfully handling more than 7000 feet of hole.

Side Latch Elevators

The present mile-deep rotary drilling oufit represents a sum of money of approximately $30,000 and around 75 tons of dead weight, not including the drill stem. The handling of long drill stems called for rapid development in the different mechanical features as well as increase in size and changes in design.

That a modern rotary outfit can be thoroughly understood we will handle the subject by sub-divisions, commencing with the power plant.

Power Plant

IN THE Gulf coast regions, two 85 H. P. code boilers with 200 pounds working pressure are used. In the Mid-Continent and Oklahoma fields it is common practice to use three 85 H. P. code boilers with 175 to 200 pounds working pressure, and in a few extreme cases rigs are using three 100 H. P. boilers with 200 pounds working pressure.

Engine

Ten by 10 and 12 by 12-inch twin engines of the reversible type are used for supplying the power to the drawworks, and rotary, and modern designed engines are using splash lubrication on all the bearings.

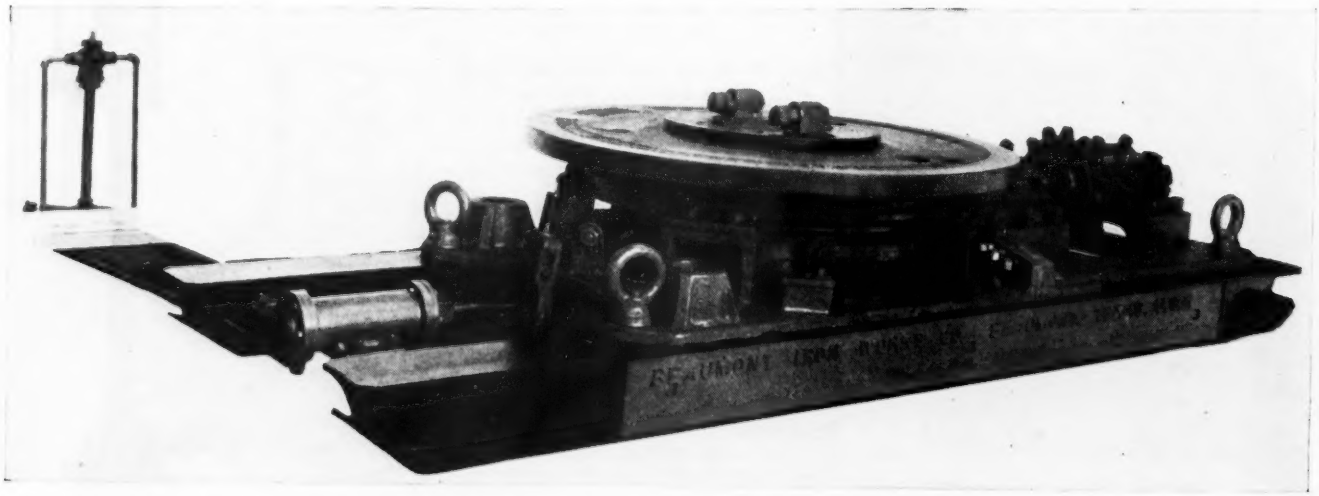
Drawworks

BECAUSE of the increased loads necessary to handle and the necessity for rapid handling of the drill stem in deep holes, the drawworks has changed from the old two-post design of the early days to the three-post design and lately the four-post design has made its appearance together with water cooled and air cooled brake flanges. Double brake bands are used and shaft diameters have increased until the modern drawworks today are using 6-inch diameter shafts and the tendency in the three-post design is to further increase the diameter of these shafts.

Manganese steel sprockets are used throughout. Bearing boxes are usually provided with two forms of lubrication, chain oiling system for the lighter oils and alemite cups for greases. All types of modern drawworks are what is known as three-speed, with a constant speed of the engine. The operating engine being a variable speed, it gives a very flexible unit ranging from a very few revolutions of the drum per minute in the lowest speed to several hundred revolutions of the drum per minute in the high speed.

This enables the operator to handle the longest string of pipe with the slower speed and as the weight decreases to increase his operating speeds by the mere shifting of a lever. In deep drilling a great deal of the time is spent pulling out and replacing the drill stem for the pur-

*Beaumont Iron Works.



A modern make and break rotary. The make and break feature can be operated by steam or hand while the rotary is in operation; a valuable feature in unscrewing and screwing together the drill stem.

pose of changing bits and taking cores. For this reason the rapid handling of pipe in the derrick is essential.

Heretofore the design in drawworks has been massive, and very little attention has been paid to qualities of material, but the idea has been to produce weight and massive appearance.

The trend today because of the excess expense in moving and handling modern equipment, is to go to quality of material and in every place possible reduce weight by increasing quality and better designing. Modern drawworks weigh approximately 18,000 pounds. This shows the necessity because of the expense of transportation, to prevent further increasing in weight. The four-post design has many advantages over the three-post for the reason that the extra bearing is close up to drum flanges and prevents the kinking of the shafts.

Crown Block

THIS being located upon the top of the derrick and so placed that regular and constant inspection is not had, is receiving more attention today from manufacturers and operators than any other part of the hoisting equipment. Many changes are taking place from the conventional design which is illustrated by photograph attached. Anti-friction bearings are replacing the ordinary bronze or white metal. Manganese steel sheaves are replacing cast iron. The trend is to a design of block that will permit of the use of larger diameter sheaves and will provide a positive lubrication to the anti-friction bearings.

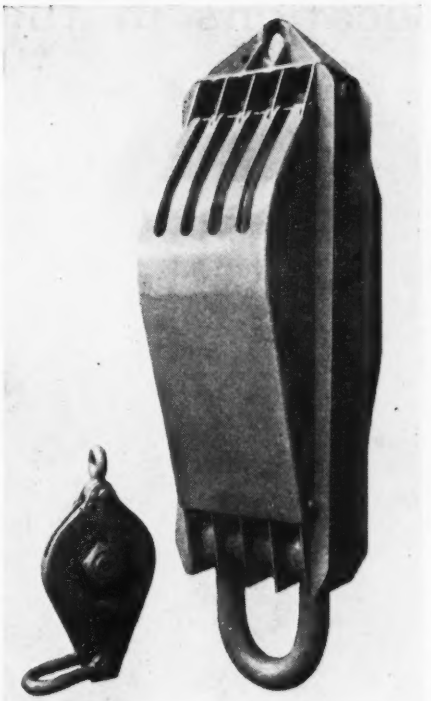
Traveling Block

THE traveling block has made progress and seems to have reached the limits required for the present loads with ample factors of safety. Larger diameter sheaves of manganese steel, anti-friction bearings and positive lubrication, together with adequate guards for the protection of workmen, and strength beyond the capacity necessary, together with weight, to rapidly overhaul the lines when the traveling block is being lowered light from the top of the derrick, all these problems have been met and solved and a very satisfactory operating unit from both the point of the manufacturer and the user is being generally used.

Slush Pumps

MANY changes have been made in slush pumps, and because of the nature of the slush handled, which contains a great amount of sand and other foreign matter, it is a very difficult problem to handle from an engineering standpoint.

The trend of all pump designers today is to what is known as the straight flow pattern, called, by the original designer, the "straight-shot." Long stroke and slow moving parts are also being incorporated in the design. Because of the nature of the slush pump, the pistons, rods, liners, and valves in the fluid end, are subject to severe conditions.



A modern traveling block, four-sheave type, and alongside it a single-sheave tubing block. This traveling block weighs 5600 pounds. In this block Timken bearings are used.

Many designs have been tried and much experimenting been done to somewhat eliminate this condition, with varying degrees of success. Modern thought is looking to a combination of a screw type and a centrifugal type pump without valves that will somewhat solve this problem. So far nothing has been actually developed, but the trend to use electric motors or internal combustion engines for driving rotary drilling equipment, has had the further effect of stimulating designers on some type of revolving pump.

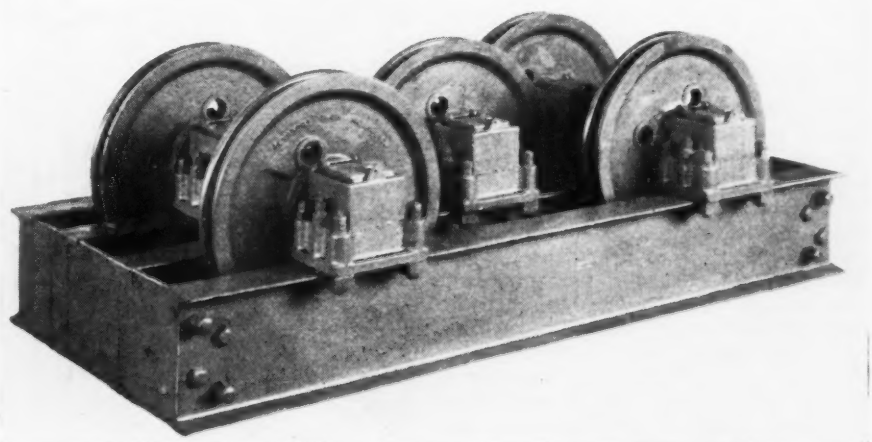
Rotary

TWO types are in the market, what is known as the plain table and what is known as the "make and break." Both types have their partisans and have their places in actual use. The modern trend, however, is to the make and break rotary for the reasons that it enables the operator to unscrew and screw together the pipe with less physical exertion and with greater speed. The present rotary manufactured seems to be generally satisfactory for the purposes, and no great effort is being made by either operators or designers to change the present designs, but only to refine where necessary to simplify operations.

Side latch elevators and spring latching tongs, together with automatic cat heads on the drawworks and what is known as shot gun or steam feed break outs have done much to speed up the handling to drill stem in and out of the hole. Constant refinements and progress are being made in these articles without any essential change in principles or design.

Heretofore because of the psychology and the lack of knowledge of the strengths of materials by the average operator, manufacturers have been forced to add weight at different points that their engineering staffs felt were unnecessary. This condition is rapidly changing because of the better quality of material and the experience of the operators with equipment in the field. Today, heat-treated shafts of alloy steel are fast replacing the old cold rolled or turn and polished shafting.

Manganese steel castings are fast replacing iron castings in all parts of a modern drilling ring. Anti-friction bearings are fast replacing the ordinary type of bearings.



Crown block now generally used. It has semi-car journal bearings arranged so they can be packed with waste and oil

Electrical Applications in the Oil Industry

By T. D. Williamson*

SEVERAL years ago a survey, made by the electrical industry, disclosed the fact that the percentage of electric equipments to other prime movers, in the automobile and rubber industries, was respectively 80 and 85 per cent, a similar comparison disclosed the fact that but 5 per cent of the possible power in the oil industry consisted of electric equipment. It has been generally conceded, even by the industrial officials of other countries, that the position of the United States as the leading industrial country of the world, is due primarily to the wide application of electric drives in all phases of our manufacturing establishments.

It was therefore, somewhat disconcerting, when the situation was analyzed, to realize that the second largest industry in this country used such a small percentage of electric power, when the success of all the other large industries was attributed directly to this one reason. This backwardness in the oil industry to adopt electric power more readily at that time may have been attributed to several specific reasons, the principal ones of which are:

First: Reluctance of manufacturers of electric equipment to appreciate the volume of business available in this industry, and to design and develop motors especially adapted to its needs.

Second: Lack of reliable power in the oil fields, at current rates which the oil companies could afford to pay.

Third: Tendency of the oil operators to retain types of equipments which have been in use for many years, and the feeling that gas is "free fuel," while electric power would merely be an "additional expense."

That these objections have, in a large measure, been overcome is conclusively proven by the fact that in one large field in Oklahoma, Seminole, more than 100,000 horsepower in electric motors are now in operation. Although no recent survey as to the amount of electric power in use in the oil industry, in proportion to other prime movers has been made, there is no question but that the percentage is now much more favorable than it was three years ago. It is also safe to conclude that with the increased use of electric motors, and as the advantages and economies are appreciated by the executives of the oil companies, the time is not far distant when this industry will be as completely electrified as the other leading industries of this country.

*President, Petroleum Electric Co.

T. D. WILLIAMSON

In briefly discussing electric equipment and their applications, I will endeavor to arrange them in the natural sequence, from the drilling of the oil well, to the handling of the finished product.

Oil Well Drilling

Cable Tool Method:

The first oil well to be drilled with an electric motor, in Oklahoma, was that of the Roxana Petroleum Corp., 11 miles northeast of Guthrie, in 1920 and 1921. This was a wild cat well, and after considerable investigation this company decided to use the electric equipment, because of the difficulty in securing fuel and water. An electric line was built at the oil company's expense, from the city of Guthrie to the well, as no electric power was available in that vicinity. A careful record was kept of expense and results, and it was found that electric power was not only very successful, as regards drilling speed, motion of the beam etc., but also that the total cost of the drilling operation in completing the well was reduced several thousand dollars over the possible cost of steam operation.

Table 1 is a brief comparison in investment and operating costs between steam engine and electric drilling equipments.

Equipments:

In general, two schemes of application has been devised by manufacturers of electric equipment; one using but one large motor; and the other two smaller motors, both belted to the same countershaft. Both schemes have proven entirely satisfactory in operation, and each has its particular advantages and disadvantages. These two methods are illustrated in figures 1 and 2.

THE advantages of electric drive over the steam engine may be summarized as follows:

1. Elimination of boilers, resulting in decreased maintenance expense and trouble.

2. Reduction in water requirements, which in some instances represents a big expense. The only water required is for the hole, and

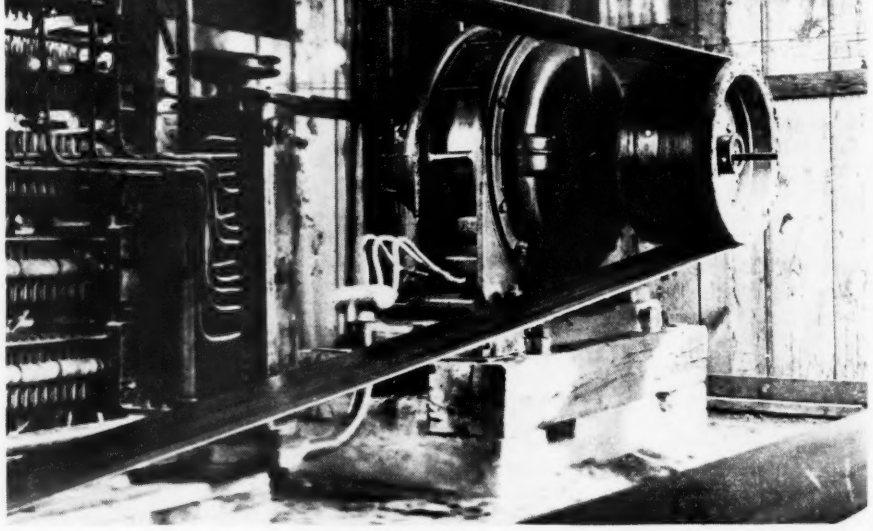


Fig. 1—Cable tool electric drilling single motor method using countershaft control equipment at left

that may be of any quality, regardless of salt or gyp content.

3. Elimination of fuel, which in the case of wild cat wells particularly represents a big item. In some cases of electrically drilled wild cat well, the cost of fuel oil and hauling would have made the drilling of the well prohibitive.

4. Since there are no boilers to fire and watch, the tool dresser spends all of his time in the rig, where he is most needed, and is of greatest help to the driller.

5. With the electric motor it is possible to pull the boiler and tools out of the hole faster. With the steam engine, the speed lags as these approach the top of the hole, but with the motor, which operates at a constant speed, and due to the rope, piling up on the rope drum, the speed is actually faster than at the start. This increased speed results in faster drilling, and a more quickly completed well.

6. Because of the flexibility of motor device, the casing crew is able to set heavy pipe more easily and quickly than with steam engine drive.

7. Since the electric equipments weigh less than boilers, steam engines, etc., they are more easily transported to new locations, and at much less expense—sometimes a very big saving in the oil fields.

8. Much data and many comparisons prove that when drilling under similar conditions, electrically drilled wells are almost invariably completed in a shorter time than when drilled by steam equipments.

Rotary Method:

Recent improvements brought out by equipment manufacturers, in devices for use in rotary drilling, have given considerable impetus to the use of electric motors in this application. These equipments are the differential drives, which makes rotary drilling practically automatic. In the earlier applications a variable speed motor was direct connected to a speed reducer, and this in turn was used to drive the draw works by means of a chain. The advantages enumerated under the cable tool paragraph are equally applicable to the rotary drive, but in addition to these are the many benefits derived from the differential equipment. The object of this device is to regulate the pressure on the drill bit at the bottom of the hole, so that when different formations are encountered the pressure or weight on the bit will be adjusted accordingly. The benefits claimed for these equipments are:

1. Greater drilling speed. This is due to the automatic feeding of the drill stem which always keeps the bit in contact with the bottom, and in soft formations, the stem moves down accordingly.

2. Less strain on drill stem, and less wear on bit, for in hard formations the pressure is regulated in accordance with actual cutting.

3. Decreased maintenance because of less strain on equipment, resulting in fewer pull-outs and faster drilling.

4. Less labor and attention required, because the pressure is automatically regulated.

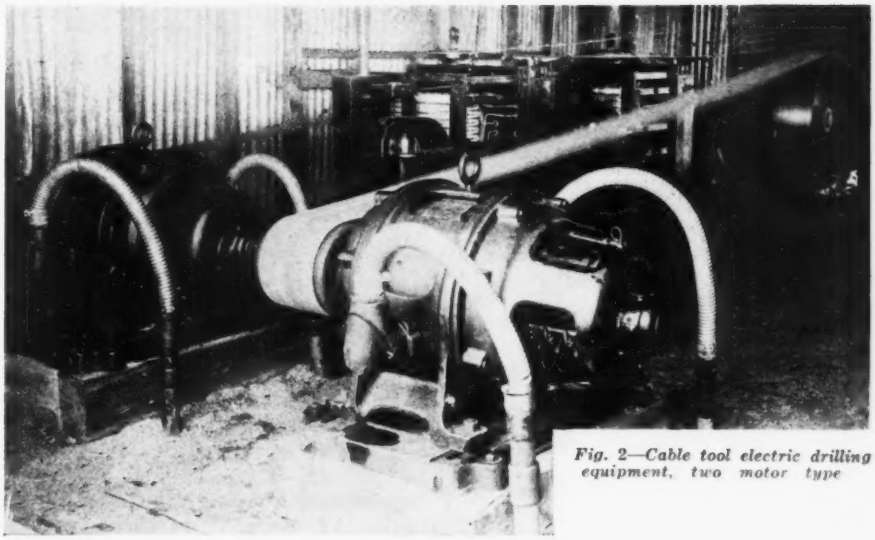


Fig. 2—Cable tool electric drilling equipment, two motor type

Producing

Pumping on the Beam:

THE first attempt to use electric motors in the oil industry was for pumping wells. Many articles have been written, giving these early experiences in detail. Suffice it to say that while in terms of present day engineering they would not be considered an entire success, many of these first motors are still in use on the original leases.

The interest of equipment manufacturers, as well as central stations and oil producers has been centered on this application of electric equipments in the petroleum industry more than any other, because it offers the largest field, in number of equipment, which could be used, as well as the greatest opportunity to effect economies. The first applications of electric drives merely consisted of a motor, replacing the gas engine, with the addition of a back gear, attached to the motor or a countershaft, to which it was belted. For this purpose, the two horsepower two speed variable speed motor was best suited, for it most nearly met the operating conditions of the gas engine, which it replaced. This application, served to acquaint the oil man with the advantages of motor drive, and the economies which could be effected by its use. Manufacturers of electric equipments are striving continually to improve the operating characteristics of their machines, to give them larger overload capacities, and to make the control equipments more dependable and fool-proof.

THE drilling of deeper wells has imposed a proportionately heavier duty on the pumping equipment, and has been the cause for machinery manufacturers to bring out an entirely new unit. This is the gear reduction unit using spur-herringbone or worm gears—to which the motor is direct connected on one side, and the crank on another.

These gear units eliminate the use of band wheels, belts, belt way, countershaft, large motor house, etc., and as a result the total investment is very little, if any more in the total installation over the former belted rig. In addition, the gear units require but little maintenance, and if a well is abandoned, the entire gear unit may be salvaged.

With the extensive use of electric power in the oil fields efficiency is becoming a real factor, which means the saving of vast sums in power costs to the oil operators. It has been proven by actual tests that the efficiency of belted rigs, from the motor pulley through the countershaft and hand-wheel and walking beam to the polish rod is 35 per cent. In other words, 65 per cent of the power out of the motor is lost in belt slippage, bearing friction, etc. between the motor and the polish rod. This loss is reduced more than 50 per cent by the use of gear units, according to the guarantees of the various manufacturers, and this point of advantage alone would justify the installation of geared pumping units in preference to belted rigs.

To further improve the efficiency

of these units, and also save wear and strain on equipments, various types of counterbalances have been devised. As a result of tests and experience it is found that the ideal counterbalance is the centrifugal type, attached to crank or crankshaft, which can be easily adjusted; has sufficient weight to properly counterbalance the rods; and may be entirely removed or detached during the cleaning or cleaning-out operations.

The two horsepower, two speed variable speed oil well pumping motor is readily adapted for use with any of these gear units. However, the two speed feature is not necessary, for, as mentioned above, the desired pulling speed may be obtained by means of the sprocket wheel ratio between the gear unit and the hoisting unit. A certain electrical equipment manufacturer has appreciated these facts and built a special oil well pumping motor of the following characteristics: Two horsepower; single, variable speed; pumping side full load efficiency 90 per cent, power factor 91 per cent, pulling side torque, 450 per cent of full load torque.

IN ADDITION to having much better operating characteristics than the two speed type oil well pumping motor, the first cost of this motor is also much less than the two speed type. In addition to improvements in the motor characteristics, this manufacturer has also made the control equipment simple and foolproof, and such parts as the resistance units, which ordinarily are subject to breakage in rough handling, are made of such material that they cannot be broken.

The latest development in geared oil well pumping units consists of an arrangement of pinions and gears by which two speeds can be obtained, merely by moving a handle on the outside of the gear frame. This results in the low speed for pumping and a high speed for pulling rods and tubing, cleaning-out and drilling. The ratio between the two speeds has been selected as 2½ to 1, but may be varied to meet operating conditions.

Much has been written about the comparative amount of oil which can be produced from a given lease by motors as contrasted with other prime movers; and this subject has been discussed pro and con many times. Records have been compiled by a number of oil producers, and these being facts cannot be questioned. In reproducing some of these records it has not been the intention to criticize any type of equipment, but merely to make a comparison of results obtained. After all, an oil company desires to produce as much crude as possible, at the least expense, and the equipment which gives the best results in respect to these requirements will be given the most favorable consideration.

Table No. 1

	Steam Engine and Boiler	Motor, Electric Line, etc.
Initial cost	$2,150.00	$3,350.00
Operating costs (monthly)		
Depreciation (25 per cent) and interest (8 per cent)	60.00	
Depreciation (10 per cent) and interest (8 per cent)		50.00
Fuel oil 18 barrels per day at $1 and $2 hauling	1,620.00	
Electricity at $15 per day		450.00
Water at $8 per day	240.00	
Water for drilling only		80.00
Fuel oil, for sharpening bits ½ barrel per day at $3 per barrel		45.00
Totals	$1,920.00	$ 625.00
Saving in operating costs, motor over engine, per month		$1,295.00
Saving per day		43.00

One of the larger oil producing companies in California installed electric motors on a property which had been operated by gas engines. It was found that the average production per day, after the electric equipments had been in use for a number of months, was increased from 380 barrels to 424 barrels.

Table 1, compiled by another of the largest operators in California, shows a saving in operating costs of $1.01 per well per day with electric motors over gas engine equipments.

The Bureau of Mines has made a thorough investigation of relative lifting costs on a large number of wells, located in fields scattered over the entire country. Table 2 contains a summary of this data.

Note: These costs include all field costs, such as labor, teaming, repairs, tools and supplies, water and fuel. These costs do not include cost of property, taxes, interest, sinking fund, overhead and general expenses, depreciation, development or depletion.

Central Power Pumping:

Electric motors have proven ideal prime movers for driving band wheel or geared central powers. For this application it is necessary that motors of "high starting torque" characteristic be used, to overcome the friction load of the power, pull rods, pumping jacks, etc. Constant speed motors, with large starting capacities, and controlled by push buttons and contactors are used on a very large number of installations. It has been found that the smooth, even speed of the electric motors results in less pull rod breakage, reduced wear on powers and other equipments and fewer shut-downs. A typical installation of electric motors driving central power is illustrated in figure 7.

Air Lift:

The most recent development in the production of oil, is the application of air or gas lift. The first field in which this method has been applied on a large scale is at Seminole, where several thousand horsepower in electric motors are in use, driving the compressors. In figure 8 is shown an example of the design, arrangement and equipment of one of these compressor stations. The advantages found in the motor over other prime movers, and which is responsible for so many electrical equipments having been installed are:

1. Lower first cost.
2. Lighter weight for same horsepower capacity, meaning large saving in freight, hauling and foundation expense.
3. Can be installed quicker, hence more recovery of oil.
4. Easily transported and reinstalled in new location.
5. Large salvage value.

Pipeline Pumping

Greater progress, proportionately, has been made in the application of electric motors to the driving of pipeline pumps, than in any other phase of the petroleum industry. While but a few hundred horsepower in electric motors were used two or three years ago, and these for small gathering pumps; today thousands of electrical horsepower are in use, many of which are in main

Table No. 2

Comparative costs of gas-engine and electric operation of wells pumping on the Beam by a Large Oil company in California.

	Per Well Per Day Gas Engine	Electric Motor
Labor, including pumpers, engine repairmen and electricians	$0.893	$0.589
Fuel or electric power	0.000	0.800
Repairs	0.076	0.024
Lubricating oil, waste, packing and miscellaneous	0.186	0.038
Interest (7 per cent) and depreciation (10 per cent on engines, 4 per cent on Motors)	0.509	0.263
Production lost from shutdowns on 50 barrel well, at 80 cents per barrel	1.172	0.028
Totals	$2.836	$1.742

Table No. 3

Type of Power	Lifting Method of Pumping	Cost Per Barrel Number of Wells	Location-Depth	Cost Per Bbl.
Gas Engine	Beam	896	5 States 1000′ to 3900′	$1.547
Gas Engine	Power	1891	8 States 500′ to 2200′	0.808
Electric Motor	Beam	417	3 States 750′ to 3100′	0.745
Electric Motor	Power	267	1 State 300′ to 2000′	0.250

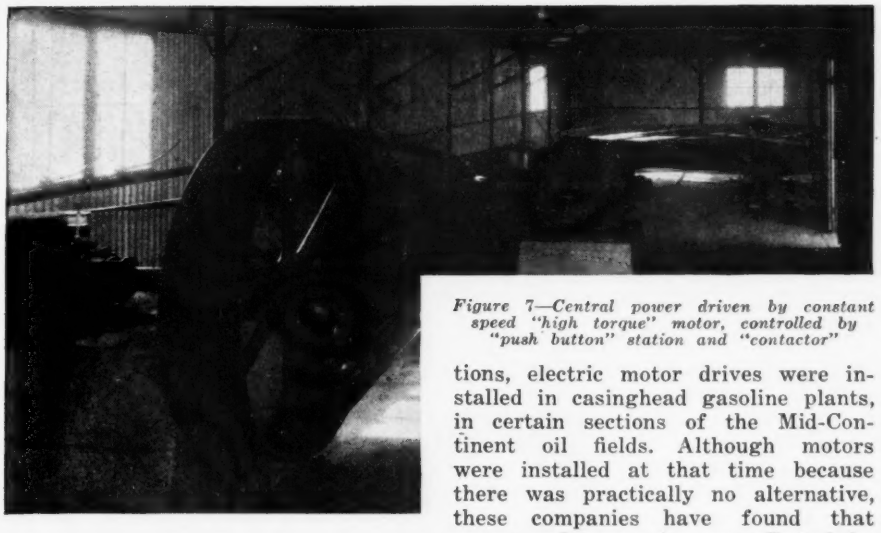


Figure 7—Central power driven by constant speed "high torque" motor, controlled by "push button" station and "contactor"

line stations. These phenomenal results are due to investigation and trial, for it was found from actual experience that the cost per barrel pumped, all items considered, was the lowest for electric motors, than for other prime movers, steam, oil or gas engine. The item of first cost also entered very largely into these considerations, the initial investment in a motor driven station being about one fourth of that in steam or oil engine driven stations of the same pumping capacity. Pumping stations similar to figure 9 and 10 may now be found in many sections of this Mid-Continent as well as California oil fields.

Data collected over several years, and from a number of pumping stations shows that the average cost of electric power per barrel of crude oil pumped, at pipeline pressure of 500 to 800 pounds, is between four and six mills. The total cost per barrel is, therefore, but little more than these figures, for the total investment is relatively small, items of maintenance and repair are negligible, labor is considerably reduced and there is no lubricating oil expense for the motor.

The latest development in pipeline pumping equipment is the centrifugal pump, to which electric motors are readily adaptable, because of the high speed. A number of automatic pipeline pumping stations, using motor driven centrifugal pumps and requiring no attendant—merely an occasional visit of an inspector, are now in operation. With these stations no tankage is required for the pumps operate in series, and if for any reason a pump is stopped, the preceding units will pump through it without any interruption in operations. This arrangement greatly simplified the installation and operation of stations, and further reduces pumping costs.

Gasoline Plants

Several years ago, due to shortage of fuel and bad water conditions, electric motor drives were installed in casinghead gasoline plants, in certain sections of the Mid-Continent oil fields. Although motors were installed at that time because there was practically no alternative, these companies have found that many real economies are effected by the use of electric equipments. The steady, even speed of electric motors results in the handling of a greater volume of gas through the compressors—and consequently, more gasoline is produced.

About three years ago one of the progressive oil companies experimented in the installation of individual motor drives on all auxiliaries in one of its gasoline plants. The results of this trial was so satisfactory that this company has installed motor driven auxiliaries in all gasoline plants built since that time, and a majority of gasoline plants constructed during the past two or three years are similarly equipped. These operators have found that the advantages of motor driven auxiliaries over belt driven types may be summarized as follows:

1. Auxiliary equipments may be located with respect to operation to be performed and not in engine room. This effects a saving in pipe, etc., and results in the decreased losses because of shorter piping.
2. The operation of the plant is more flexible for the speeds of pumps or compressors may be regulated individually. Automatic features, such as temperature or pressure regulators, may be used.
3. The greatest cause of shutdowns: belt trouble or breakage, is eliminated.
4. The first cost of complete

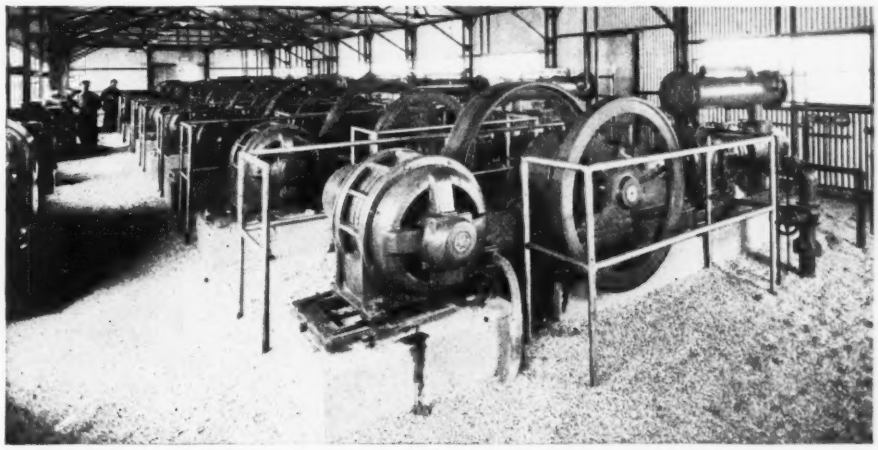


Figure 8—Air lift station Seminole, Oklahoma field, containing ten one 100-horsepower motors

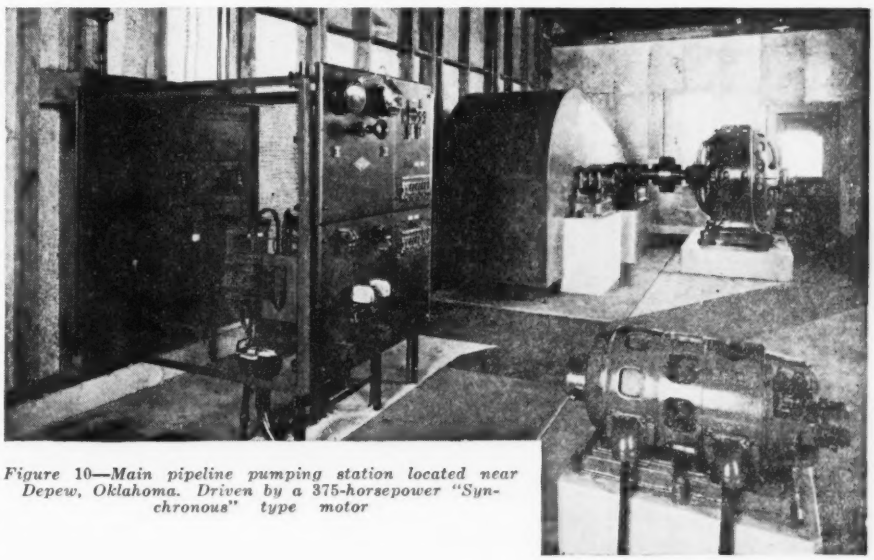


Figure 10—Main pipeline pumping station located near Depew, Oklahoma. Driven by a 375-horsepower "Synchronous" type motor

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auxiliary equipments is reduced.

A gasoline plant in which the auxiliaries are electrically driven is shown in figure 12. The neatness, compactness, and safety of electric motor driven plants is clearly shown in these pictures.

Refineries

Oil refineries are very similar to other large manufacturing institutions in that margins of profit are small, and costs of operation are of paramount importance. Economy requires that the cheapest and most efficient power be used—and for this reason, electric motors have been the standard motive power in this branch of the petroleum industry for many years.

Conclusion

From this discussion it is readily seen that electric equipments are rapidly being introduced into every phase of the petroleum industry. Keener competition, increasing labor costs, and higher prices for supplies and equipments is forcing the industry to investigate operating costs, and to select those which prove most efficient and economical. It is for these reasons that we can safely expect a rapid increase in the use of electric equipments in the entire petroleum industry—for all of the other largest industries of this country have made similar investigations and gone through a like period of experimentation, and these are now almost one hundred per cent electrified.

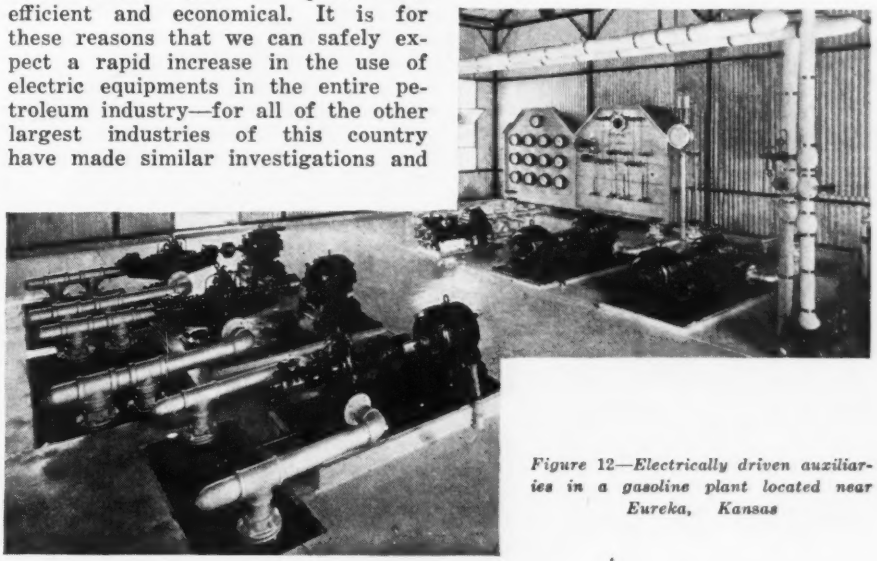

Figure 12—Electrically driven auxiliaries in a gasoline plant located near Eureka, Kansas

Crude Is Now Better Handled on Leases

By H. M. Stalcup*

POLITICIANS are forever damning the oil industry for one thing or another, and as often as not it is on a charge of wastefulness. There may have been a day when there was literal and physical waste of petroleum in various stages of its route from the well to the consumer's gasoline tank, but, if so, that day is about gone, as, to say the very least, conditions prevailing today represent a tremendous improvement upon those of a decade ago.

In no respect has this been more pronounced than in the improvement perfected in both practice and equipment, in connection with the handling of the crude oil from the time it leaves the well's casinghead until it is delivered into the lines of the purchaser's pipe line.

After Henry Ford worked out his so-called improvement on the bicycle as a means of locomotion, a rapid change began to take place in the manner in which the gasoline content of crude oil was looked upon. The respect for and appreciation of this constituent of petroleum kept pace with the development of the automobile, which is another way of saying that it grew by leaps and bounds, so much so that we find the increase in the demand for and consumption of gasoline in the last 10 years to be without parallel in the annals of industrial history.

One of the first reflections within the oil industry of this increased demand is found in the posting of the first gravity schedule price basis for the purchasing of Mid-Continent crude oil by the Prairie Oil & Gas company on Nov. 22, 1922, and the industry's real effort at efficient handling and conservation of crude oil starts with that date, as the new gravity basis of purchase had the practical effect of placing a premium on the high gravity, high gasoline content crudes.

Prior to this date in the Mid-Continent area, a barrel of oil was simply a barrel of oil, that is to say, no distinction was made as to the gasoline content or general character of the oil, but a flat price was paid for it, good, bad, or indifferent. Prior to this time, there being little or no incentive to conserve gravity, most any kind of lease tankage sufficed to serve as a medium through which to gauge the production for delivery to the pipe line. For a good many years wooden stock tanks were used and that often without any semblance of a top or roof. Gradually the wooden tanks were covered and made reasonably tight and still later were replaced by bolted steel tanks. In figure 1 we have an illustration of a tank battery typical of that day and condition. Notice the wooden gun barrel or receiving tank has had a home made deck put on it in an attempt to prevent waste through evaporation. Indeed, at that time this was generally referred to as a gas tight job, but it in reality was a long, long way from approaching any such condition. The stock tanks in this battery, tightly enclosed and hidden from view by the shed, were the "last word" at that time, but decidedly out of date in 1927.

WITH the prospect of securing a premium for their crude oil, based on gravity and attendant gasoline content, producers were by no means slow in launching a campaign that almost immediately made the wooden tanks obsolete and that resulted in a decided improvement in the general conditions of their bolted steel tankage.

As the advantages to be gained by tight tankage became more generally appreciated, the vapor-pressure or so-called gas tight tank was developed from a better design and more thorough construction of the conventional bolted tank, so that a few ounces of pressure might be maintained, thus largely preventing the escape of the lighter fractions of the crude. As compared with the crude layout in figure 1, the vapor pressure steel tank battery, pictured in figure 2, illustrates the tremendous advance made in a very few months from the date of the inauguration of a new order of things with respect to the basis of crude oil purchase. The leaks at many of the seams of the tanks in this illustration, however, clearly indicate that this type of tank construction, while admittedly a big improvement over that formerly in use, left much to be desired.

As the number of automobiles con-

*Vice-president in charge of production, Skelly Oil Co.

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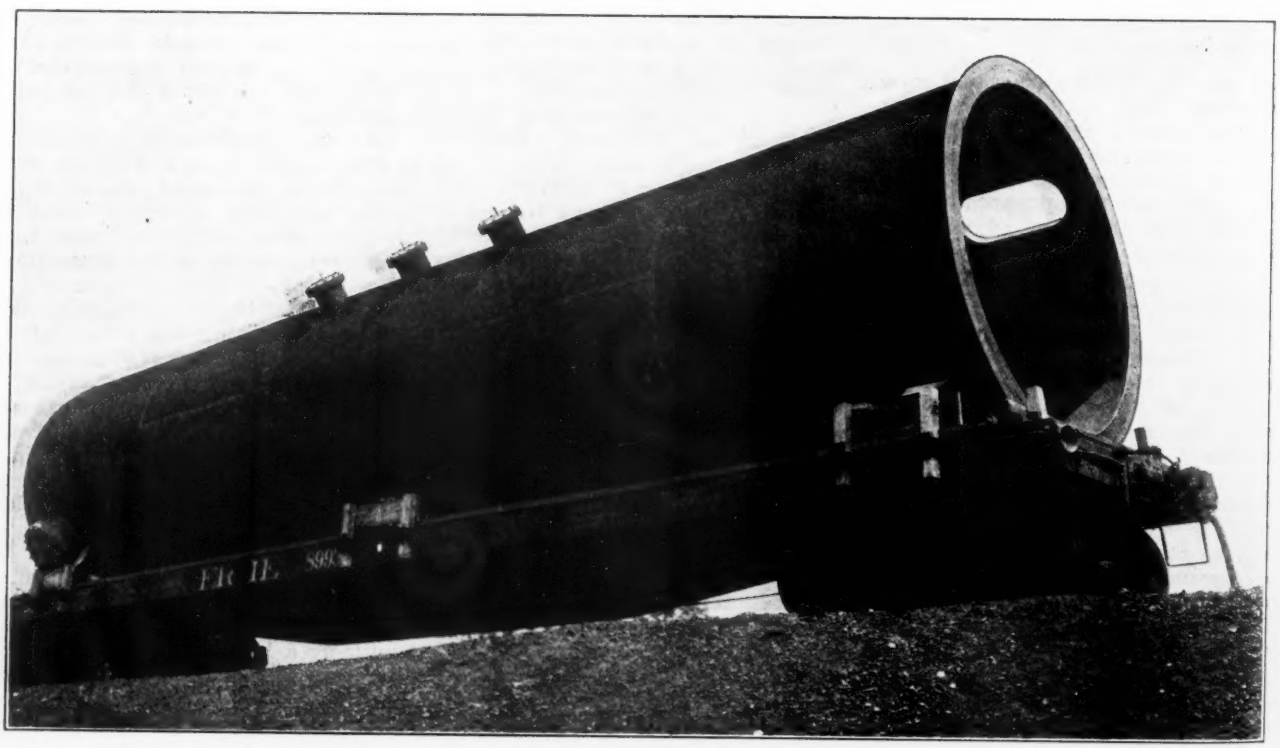

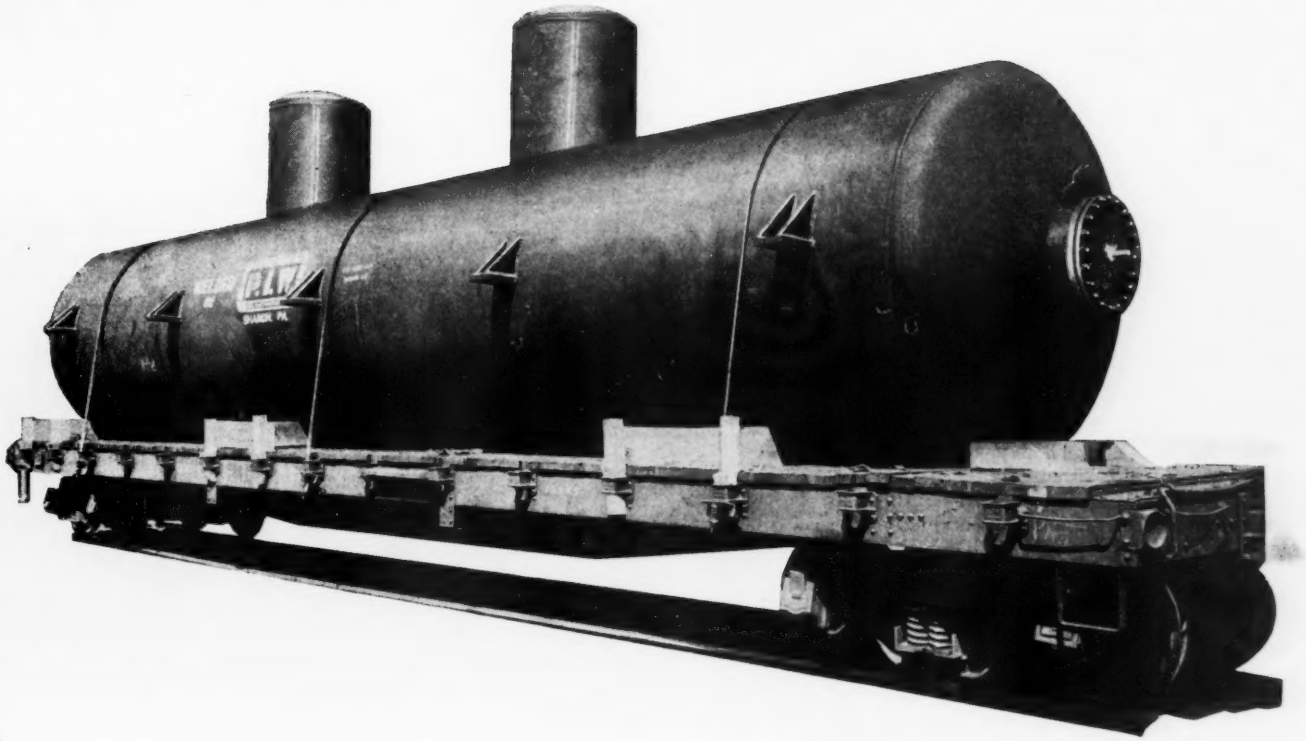

With the advance of the cracking processes there grew the need for a new and superior type of vessel that would withstand pressures heretofore unheard of day in and day out with perfect safety. In addition the very last degree of accuracy had to be observed in fabrication. The result of this need was the development of P.I.W. Welded Pressure Vessels. Now in quantity production after the most exacting experiments and tests these vessels are establishing new standards of strength and accuracy coupled with low first cost and minimum maintenance.

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tinued to steadily and rapidly increase, accompanied by a corresponding demand for gasoline, we find the crude oil purchasing agencies offering still greater inducement to producers to conserve their oil and maintain its gravity at the highest possible point, by the adoption on July 10, 1925, of a gravity price schedule that established a differential of 8 cents per barrel for each degree of gravity above 28 degrees Baume.

Additional effort upon the part of progressive producers to take every economic advantage of this still more attractive premium for high gravity crude took the form of the adoption of electro welded or riveted steel tanks constructed of heavy plate and upon which a pressure of several pounds may be easily carried if desired. One of these modern and efficient tank batteries is shown in figure 3. These tanks are usually purchased for lease tankage purposes in two sizes, 90 barrel and 210 barrel. according to the volume of production to be handled, and have proven very satisfactory indeed. The only instances where some Mid-Continent operators do not now install this type of tank battery is on properties producing very low gravity oil or to take care of flush production from

Figure 1. Old wooden crude oil storage tank on lease

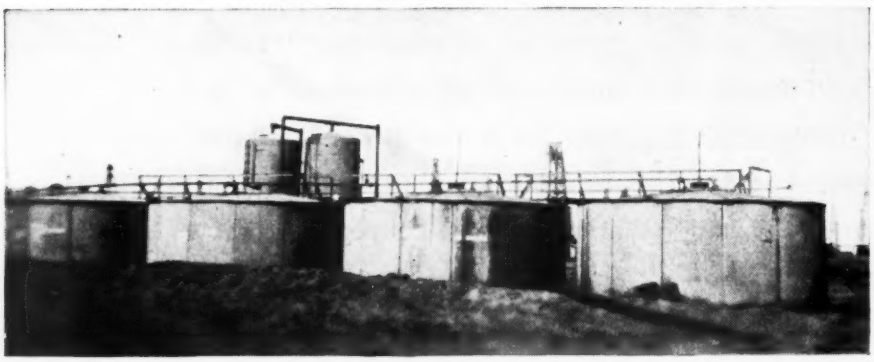

Figure 2. Battery of vapor tight steel tanks

properties where large flowing wells are encountered and where 500 or 1,000 barrel tanks, impractical sizes for welded construction, must be used. Upon such properties, however, as soon as the production declines to a semi-settled state, a permanent battery of the welded tanks is usually installed.

AS AN illustration of the efficiency and economic advantage of this type of equipment, the experiences of one company will be found interesting. After the wholesale installation of such tankage upon practically all of its properties in the summer and fall of 1925, and at an investment cost of approximately $100,000 over and above the credit derived from the salvage and disposition of the older style bolted tanks, it was agreeably surprised to find that such change in equipment had, by the close of 1926, netted it an estimated increase in revenue of $144,000. This record speaks volumes for the efficiency of this type of tank and as to the economic soundness of making this drastic change in equipment, even though the company mentioned was, in this case at least, on any broad basis, "the first by whom the new was tried," and by the same token, not "the last to lay the old aside".

Incidentally, one of the principal and deciding factors in connection with this company's standardization on the welded lease tank was its belief that in adopting this equipment it would not only find it beneficial in maintaining gravity, but that such tanks would prove of an economic advantage in getting away from the heavy expense incident to the cutting down and rebuilding of the bolted tanks nearly every time they were to be moved, as it was found that when one of such tanks had been moved three times, which is not at all an unusual occurrence, more money had been spent in intangible labor charges than was represented in the original cost of the tank itself.

Expectations along this line have been borne out by two years of experience, as it has been found that the welded tanks may be easily and quickly skidded upon a truck and moved from location to location, lease to lease, or, in fact, district to district, with a most favorable hauling charge, and at a total cost of but a

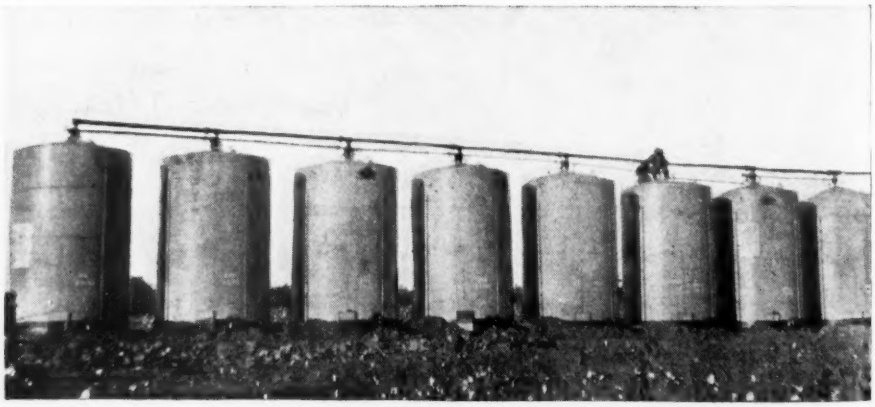

Figure 3. Battery of modern electric-welded tanks

fraction of that experienced with the older equipment and method.

An added economic advantage lies in the fact that on account of the much heavier plate from which the welded tanks are constructed, they are found to be practically indestructible, and will consequently be serving their useful purpose and giving a good account of themselves after 25 years of service.

In the illustration of a typical modern welded tank battery in figure 3, it will be noticed that each tank is equipped with a gauge glass extending the height of the tank, with an individual gauge pole alongside, that makes it possible for the pumper to take his daily gauge and check the production of his lease as many times during the day as he may desire without once opening the gauge hatch or thief hole, which is another way of saying that by thus keeping the tank closed, the usual and customary waste of both volume and quantity through evaporation is prevented, so that the oil is delivered into the pipe line in as near it virgin state as is possible. Particular attention is called to the fact that these welded batteries are unsually set on foundations of crushed stone, chat and sand, over which is placed one thickness of heavy tarred building paper which has proven beneficial in preventing corrosion of the tank bottom. There being no chance of leakage from this type of tank, it is not necessary to build the time honored fire wall, which adds to the economy of the installation.

FOR efficiently handling the flush production from flowing wells in such manner as that waste shall be reduced to a minimum, the industry has in recent years quite generally adopted oil and gas separators as part of the standard hook-up. Such a separator, which displaces, and which is a decided improvement upon the flow tank, formerly in use, efficiently and automatically separates by means of interior baffles the oil and gas, and consequently tends to raise and maintain the gravity of the oil at the highest possible point, and makes delivery of the casinghead gas to the gathering lines of the gasoline plant dependable and certain, and, upon the whole, is one of the most important developments of recent years on three points, economy, efficiency, and conservation.

Along with these changes in tank batteries has gone the installation of pressure treating systems on those properties where treating with heat is necessary, and this change has effected a remarkable increase in the gravity and in the prevention of evaporation. It has been found that where it is necessary to treat high gravity oil at a relatively high temperature, it is advisable to cool the oil by water sprays, if practical, to reduce such temperature sufficiently to bring it below the boiling point of the lighter fractions of the oil.

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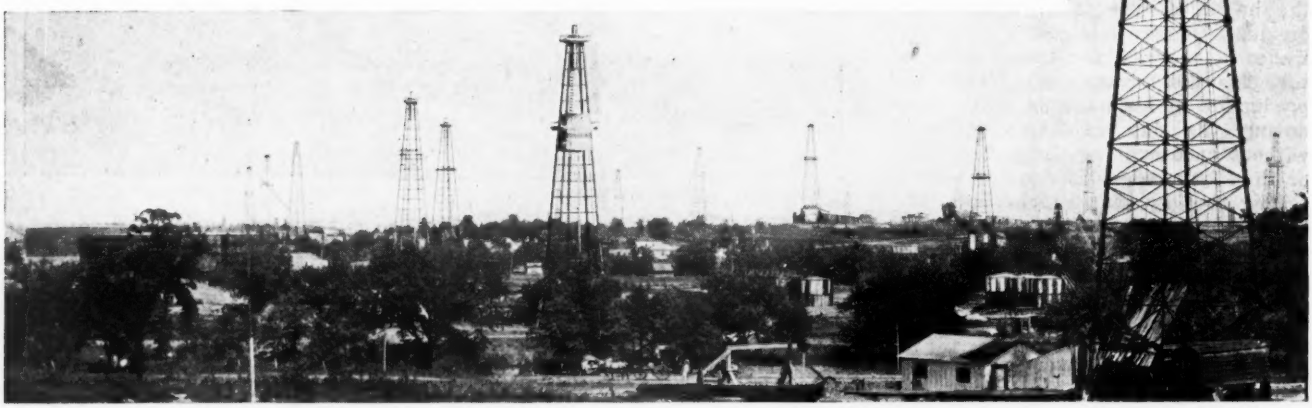


General view of the Seminole field showing derricks of various late types

THE early type of derricks used in the Pennsylvania fields in drilling the Drake well in 1859 and after that for some time were constructed of poles 28 to 30 feet long cut from the adjacent woods and framed together with spikes, wooden pins and other crude devices to form either the tri-angular or tripod structure or the square derrick.

It is an interesting fact to note that labels pasted upon bottles containing crude petroleum and sold for medicinal purposes by one Samuel Kier of Pittsburgh in 1848 showed a four legged braced derrick, even though the oil in them had been secured from seepages, springs, and shallow pits dug in the sand.

The first well drilled for oil was known as the Drake well, and it was sunk by hand in 1859, and pictures of the old derrick over this hole show that it is a pyramidal frame completely covered with rough boards, being of the type now termed a winter rig. It is understood that the building provided sleeping quarters for the driller "Uncle Billy" Smith and his crew while the well was being sunk.

This is, however, by no means the first well to be drilled in the United States for the first volume of the West Virginia Geological survey gives an account of an artesian well drilled in the Kanawha valley at Salt or Buffalo Lick near Charleston, W. Va., in 1806 for salt brine by two brothers, David and Joseph Ruffner.

The early method of securing power with which to drill these small holes was by the use of what is known as a spring pole, usually made from a sapling of ash or hickory from 12 to 20 feet long, one end of which was fastened to the ground and the pole bent over a forked tree or some other convenient fulcrum.

To the free end of the pole stirrups were attached into which the operators would swing themselves, and in this way the pole would be sprung downward and the drill stem attached to it would be driven into the earth, and lifted quickly when the men released their weight in the stirrups.

In some instances the tools were hoisted entirely by hand, but some operators built a tripod over the hole, to which they attached a sheave and hand windlass for hoisting purposes.

These crude methods of kicking down a well were practiced in the rush that followed the drilling in of the Drake well, but the use of steam for power was soon resorted to and had its influence upon the type of structures built for the hoisting of tools and lowering of pipe for oil wells.

IN EDWIN C. BELL'S article on the early days of the oil industry he shows a picture of the old Benninghoff Run field in Venango county, Pennsylvania in 1866 where it is noted that a very simple form of wooden derrick was used made from timbers cut from the woods of that country.

These structures were conspicuous as compared with the more modern wooden derricks because of the arrangement of the girts and braces. The girts were nailed on the inside of the legs and the braces spanned two sections, but on some derricks they were omitted in the top sections. On some of these structures the braces were so placed that one was on the outside of the girt and the other on the inside.

The ladders were nailed on the side of the derrick most convenient for the driller, and some ladders were constructed by nailing cleats on a leg.

THE Faber drilling engine of 1860-61 was direct connected with the walking beam for pumping and drilling; that is, the equipment of the walking beam was attached to the fly or balance wheel of the engine, instead of a belt extending from the balance wheel of the engine to a band wheel, having a crank to which the walking beam pitman was attached.

With this engine the boiler was set in the same house and the two connected by a copper steam pipe. The engine was made reversible by what was then named a lazy bar in connection with a rocking shaft. This reverse was operated by shifting the gear from one shaft to the other.

This type of equipment was reflected in the details of the derrick design, but evidently the Faber engine did not meet with much success for the belt driven band wheel was introduced for the use of rag lines, or hemp rope, making the bull wheels

*Sales engineer, Parkersburg Rig & Reel Co.

necessary. With the Faber type of engine the drilling was done with drill rods somewhat like the present day sucker rods and these rods were direct connected to the end of the walking beam.

The bull wheel, used in modern derricks for spooling drilling cable or rope, had its origin in China. In an article written by Louis Coldre and printed in Western Engineering in December, 1914, he shows the cuts illustrating the chinese drilling methods.

THE Chinese are credited with having known of the art of sinking wells for salt by drilling methods for many centuries and by the year 1700 had reached a fair state of development. They are credited with having obtained gas and some oil from these wells. The gas was piped to where the brine was stored and then used under the kettles to heat the salty solution preparatory to preciptating the salt by evaporation.

The ancient Chinese, it is claimed, drilled wells as deep as 3,000 feet. To draw the cable tools from this great depth, they used bull oxen attached to the sweep of a windlass or large drum shaped wheel. When modern operators began to work with hemp rope they adopted a wheel of somewhat similar form and designated it the bull wheel.

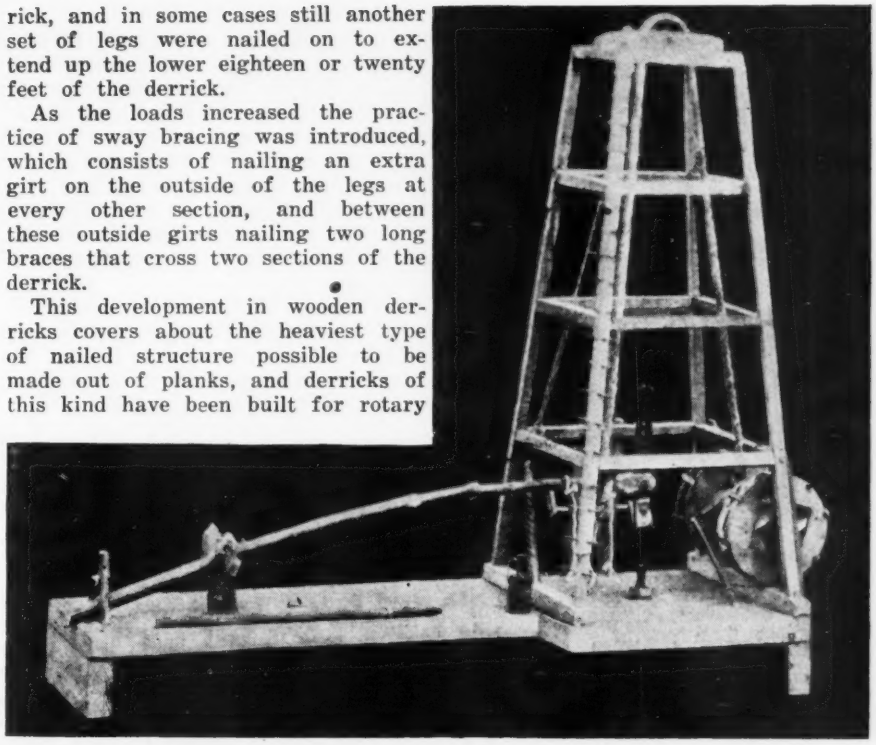
The introduction of the bull wheels into derricks had its influence on the design, and along with the improvement in engines, boilers, tools and equipment generally, gradually changed the details of wooden derricks, but they were built for percussion or cable tools only from 1859, when the Drake well was drilled, until October, 1900, when Capt. A. F. Lucas first introduced the rotary methods in the Spindletop field of Texas. Light rotary outfits weighing complete only about 1800 pounds were used for drilling water wells to shallow depths in Corsicana field in 1896 to 1899.

The wooden derricks are normally built of 2 inch x 10 inch or 2 inch x 12 inch timbers nailed together to form a 90 degree "V" shaped trough. At first this lumber was rough hewed from native timber cut as near the location of the derrick as possible, but as the demand increased and the woods in the immediate vicinity of the oil fields disappeared the use of rough sawed dimension lumber became more common.

Girts and braces were increased, the braces being placed at every section, or about 7 feet apart, and where added strength was desired the legs were increased in thickness by nailing on other 2-inch pieces to form what is commonly called doublers. These doublers would extend from the base to the water table of the derrick, and in some cases still another set of legs were nailed on to extend up the lower eighteen or twenty feet of the derrick.

As the loads increased the practice of sway bracing was introduced, which consists of nailing an extra girt on the outside of the legs at every other section, and between these outside girts nailing two long braces that cross two sections of the derrick.

This development in wooden derricks covers about the heaviest type of nailed structure possible to be made out of planks, and derricks of this kind have been built for rotary drilling in California to the height of 162 feet.



The spring pole drilling equipment of 1859

While wooden derricks are still used in some fields especially where wood is cheap and the mills are close to the oil fields, the tendency is toward steel or the combination type of derricks known as turnbuckles.

IN A VERY complete paper entitled "The Evolution of Drilling Rigs," written in 1915 by R. B. Woodworth, engineer for the Carnegie Steel company and delivered before the New York meeting of the American Institute of Mining Engineers in February, 1916, he states that as far back as March 24, 1825, a patent without number was issued to L. Disbrow covering a type of four legged wooden derrick, and a second patent was issued to the same inventor on Nov. 1, 1830, in which he described a derrick put together with mortices and keys.

Other patents covering four legged braced derricks made with squared timbers were issued in 1865 and 1866, the description and claims for which indicate that even at that early date in the oil industry the inventors had in mind derricks that could be readily erected and then dismantled and moved to other locations. Most of these derricks were of the type now known as turnbuckles and depended upon the tension in the braces for their strength.

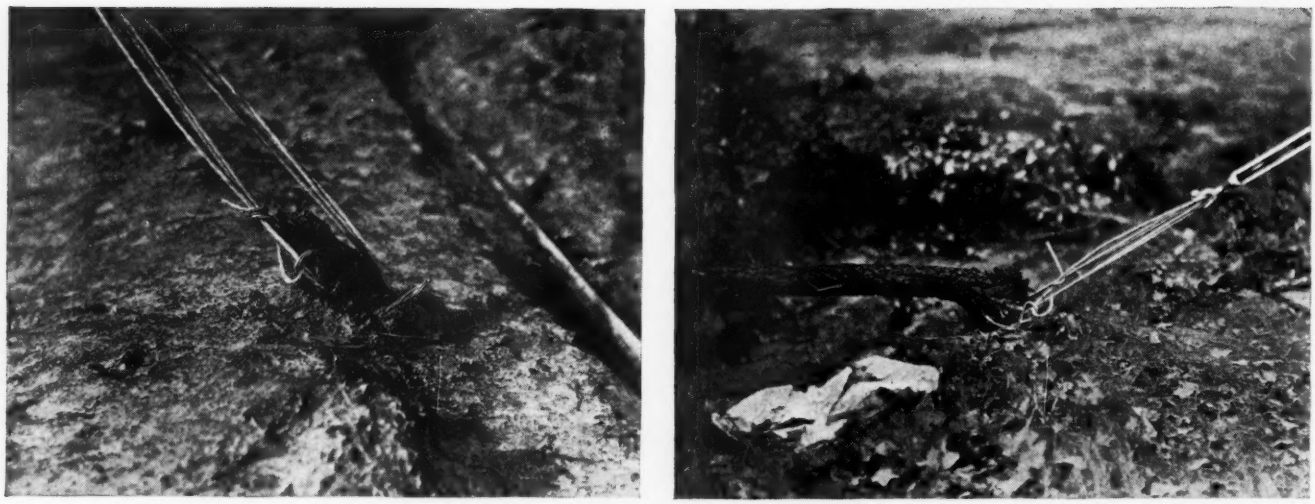
In patent number 130,706, Aug. 20, 1872, Samuel S. Fertig of Titusville, Pa., describes a sectional derrick frame, to be fastened together by the use of bolts, being, perhaps, one of the first attempts at building the bolted type of derrick now so common in all oil fields, but now built of steel.

Credit for the present type of turnbuckle is given by Mr. Woodworth to an Oklahoma rig builder, name not mentioned, who introduced a derrick built with wooden corner posts and girts in that state in 1913. Iron rods fitted with turnbuckles for diagonal braces were used.

Mr. Woodworth further states: "There was said to be a growing demand for such derricks in 1913 and they are, beyond question, suitable for use in that shallow territory, and for pumping purposes, in spite of the fact that the rig builders and drillers have not as a rule, taken kindly to the use of turnbuckles."

IN TRACING the history of pipe or tubular derricks it appears that Jesse Button of New York city received a patent dated Nov. 19, 1878, for a derrick to be constructed preferably of metal tubing, the vertical supports and cross braces being made with screw joints to permit of being readily assembled and taken apart as desired. The clamps at the joints were not fully described but would probably be made of cast iron.

In December, 1885, a patent was issued to Albert T. Hyde of Oil City, Pa., for a triangular type derrick, the legs of which were made of tubular posts, with girts and braces forged flat at the ends and punched to fit over a pin placed in the center of



Two poor examples of derrick guying

the pipe at the ends of each leg section.

Other patents were issued to George Corbett of Bradford, Pa., in August, 1886, and to Amos C. Wilson of Butler, Pa., in August, 1896, for types of pipe derricks but neither type seemed to meet with much success in actual field practice.

The first pipe derricks actually manufactured and sold to the oil industry seem to have been made by Zahniser Brothers and Sten Co. at Washington, Pa., who commenced marketing derricks of this type in 1909.

It is true that in 1908 patents were granted to T. A. Neil, field superintendent for the South Penn Oil Co. and acquired by Lee C. Moore and company covering a clamp for pipe derricks but at first Lee C. Moore and company only manufactured and sold these clamps for various sizes of pipe from 2 inch to 6 inch diameter, and permitted the customer to cut and form his own pipe for the legs, girts and braces, using for this purpose old discarded material from wells and pipe lines.

THE Neil clamps were first made of cast steel but later were changed to drop-forging which reduced the cost and made an article better suited for this purpose.

It is interesting to note that as far back as 1852 the Oil Well Supply company carried an illustration of a structural steel derrick in their catalog and described it as a structure 72 feet high made with steel angle legs, steel base and crown block and the diagonal members made of rods adjustable by the use of turnbuckles. In the description of this outfit they state in part, "* * * Every part is made of steel; power is applied by a rope running through double grooves in engine pulley, band wheel and sand reel head."

So it seems that even at this date the idea of direct driven sand reel had been conceived and actually put into practice, for they state that the first rig of this kind was sent to Australia.

In the year 1903 the American Bridge company of Pittsburgh, Pa., built structural derricks 50, 60 and 70 feet high, tower fashion, with three, four and five panels respectively, these panels having an average of 17, 15 and 14 feet, respectively.

In the same year Chester B. Albree Iron Works of Pittsburgh built two or three structural steel derricks for shipment to Vera Cruz, Mexico. They were 70 feet 8 inches high under the crown block with a base 21 feet 8 inches square, and the lower part of each leg buttressed with two additional legs.

THE Carnegie Steel company entered into the design of structural steel derricks in 1904 for the Oil Well Supply Co. and laid out details for a 72 foot high derrick of what was known as the California type, with 20 foot base, complete with the necessary machinery supports for bull wheels, calf wheels, band wheel and sand reel, each detail being so designed as to permit of the use of rig irons, wheels, etc., on the steel structure without substantial divergences from parts carried in stock by oil well supply stores and designed primarily for use on wooden structures.

It evidently took some time to find a customer for this type outfit for it was not until January, 1908, that the first two were actually constructed and one of them went to Peru and the other to Argentine.

Up to 1908 all structural steel derricks were built along the lines laid down by structural steel designing engineers without much regard for the needs and desires of the users in the oil field, and much attention was given to strength of joints in the legs, and the long panels or leg sections were used, but experience soon showed that these first structures were much heavier than the operating conditions required, and the process of erecting them could be made much simpler if shorter leg sections were used.

It was also determined by actual use in the fields that the loading of the legs was principally one of direct compression and therefore the type of leg splices could be redesigned to simplify the construction and use fewer bolts and rivets. This was done about 1910 when patents were issued to R. B. Woodworth of the Carnegie Steel company along these lines and the legs were reduced from 14 to 17 feet in length to about half that distance and the size of the angle used determined by the ratio of slenderness formula for columns which made for lighter derrick construction throughout, but still gave a structure amply strong enough for drilling wells.

In July, 1908, the late Patrick Yorke of Washington, Pa., a drilling contractor who had then had some 30 years experience in actual production of oil, made application for and was granted several patents for improvements in the art of drilling.

Among these patents was one issued on May 7, 1907, for a bolted wooden derrick, to which he subsequently added improvements on Jan. 28, 1908, and Sept. 6, 1908, and Jan. 18, 1910.

The principal improvement claimed by Mr. Yorke in his patents was the use of a slot formed in the upper and lower edges of the connection plates and girts and braces instead of round holes.

These derricks were first manufactured for Mr. Yorke by the Carnegie Steel company from Jan. 8, 1909, until 1913, when the agreement was discontinued by mutual consent of the patentee and manufacturer and the derricks built after that time by various structural steel shops in Pennsylvania, Ohio and West Virginia, until 1923 when the Yorke patents were acquired by the Park-

ersburg Rig and Reel company, of Parkersburg, W. Va., who have since fabricated these derricks at their factory there.

In 1915 when Mr. Woodworth wrote his paper it seemed that the future of the steel drilling rig was somewhat doubtful for in the conclusion of his paper he states—"While it is not at all likely that the steel drilling rig will replace the ordinary wooden structure to any more than a limited extent, particularly in the drilling of wells for oil, a sufficient number have been put into use to justify conclusions as to their advantages, based not on theoretical considerations but on actual experience."

It seems, however, that Mr. Woodworth was in error in this conclusion for in 1926, eleven years later, the Committee for the Standardization of Steel Derricks for the American Petroleum Institute found that there were over 430 different size derricks being manufactured in this country.

As with a good many other details of equipment used in the oil industry it was found that the direct change from wooden to steel construction was not acceptable, and there has been developed an intermediate type of derrick between the nailed wooden derricks and the steel structures, that are known as the turnbuckle type, which consist of wooden legs, usually made from 8 inch x 8 inch, 8 inch x 10 inch and 10 inch x 10 inch timbers, cut to seven foot lengths for the leg sections, with girts and braces of metal, or with the girts of wood and the braces of steel.

IT IS claimed for these derricks that they have the spring of the all wooden derricks with the added advantage of being fabricated in the factory and so constructed that they could be cut down and moved to a new location with a minimum of waste. The idea is not new, as shown in the first part of this article, but it seems to have been revived in about 1913 in Oklahoma and has met with considerable success.

All derricks of the turnbuckle type are much the same in principle and depend upon the tension in the braces to hold the legs in line. This makes for easy construction for it is only necessary to set the legs one upon the other in the corner clamps and join them with the girts and then hold the panel together by tightening on the turnbuckle braces that extend from corner to corner on each panel. At first some trouble was experienced in keeping the turnbuckles from loosening when the derrick was in use and under vibration but various means of overcoming that trouble have been devised, so that structures of this type are now quite generally used for cable tool and rotary drilling and for the combination rigs using both forms of drilling equipment.

Another compromise has been introduced into derrick design during this transition stage of development, and that is what is known as relegging steel derricks, and this is practiced both with the tubular and angle iron type of structures.

The object of relegging a steel derrick is to permit it to be used first as a drilling unit, and later, when the well has been completed and put on the pump, to be changed to a lighter structure by removing the relegs and allowing the balance of the derrick to remain in place over the hole that it was used to drill.

There is a good deal to be said about the practice of relegging, both for and against it, but it would seem that with the practice of deeper drilling (below 5,000 feet) the relegging of derricks will be discontinued and steel structures designed to handle the heavy loads to which this deep drilling will subject them, and after they have completed this work they will be removed and a lighter pumping derrick will be erected over the hole.

As long as relegs are to be used it will be found very necessary to so design the secondary set of legs to make certain that they will take their equal share of the compression loads placed upon the derrick, and this means in actual practice that it becomes necessary to make eight legs of equal length instead of making four legs of the same length but heavy enough to withstand the total load that will come upon the structure.

Some relegs are provided with a means of adjusting each leg to the proper length to bring it under the same loading condition as all the other legs, and a threaded jack is used in some designs, while others employ shims as a means of taking up any irregularities in the length of legs after assembly.

There is still another solution offered for the design of the combination drilling and pumping derricks in what is known as the dual type angle iron derricks, which consists of erecting the derrick first for the drilling condition, say 122 feet high and using relegs in the corners, and after the well is completed removing the releg members and then lowering the upper 87 feet of the original derrick to the same foundation level as the 122 feet derrick, the lowering being accomplished by the use of special gin poles with sheaves set at each corner of the structure. It is further claimed for this type of derrick that it can be converted into a drilling derrick again by reversing this proceeding.

A study of all of these ingenious devices for making steel structures acceptable to the oil industry for drilling and pumping are in a sense only a means toward an end, and that end seems to be indicated by a review of the report of the Standardization Committee on Steel Derricks submitted to the meeting held in Colorado Springs, Colorado, June 14-17, 1927, in which size of steel derricks were recommended as standard.

With the standardization of other material used in the oil fields by various committees acting under the auspices of the American Petroleum Institute, it seems only logical that uniform dimensions for derricks should be adopted and it can be done without inconveniencing the users in the field, especially providing other standard equipment is used.

Under this system it is possible to determine the strength of A. P. I. standard drill pipe and casing and then select the derrick with the proper size members for legs, girts and braces, these members being selected by the use of a standard formula for column loading that has also been accepted by the committee acting for the A. P. I.

THE next consideration is the selection of proper foundations upon which to erect these structures and to build them of the proper proportions to prevent overturning of the derrick by wind as well as to keep them level under working conditions.

With the use of the rotary equipment becoming more common in all fields the wind load estimates must take into consideration the additional surface exposed to the wind when the drill pipe is standing in the derrick.

For this purpose it is assumed that the drill pipe is made up into 90 foot long stands and 36 of these stands of 6 inch drill pipe are in the derrick at one time, giving an exposed area of about 360 square feet and the pressure is estimated by the formula $p = .004\ V^2$ wherein "p" is pressure in pounds per square foot., and "V" is velocity of the wind in miles per hour.

Working from this formula and adding the wind pressure that is effective upon the exposed area of the derrick with a wind having a velocity of 70 miles per hour it is possible to estimate the size of the concrete piers that will be needed to oppose this overturning moment in the structure.

Under these conditions, of course, the windward side of the derricks are under tension while the leeward side is under compression so the joints between legs should be so designed that they will withstand these stresses without failure.

Designing for these conditions sets up requirements for these structures that will necessitate that the size of

girts and braces for the derrick must be ample to keep the legs in line under all working conditions, and if the relegged derrick is so designed it will be found that there is very little advantage in using the relegs, for the metal used in making them could be easily added to the cross section of the regular leg member and give a derrick of the required specifications. This saves the added cost of erecting and dismantling the reinforcing members, which is a considerable item when considered separately.

THE dimensions of the derrick foundation piers must be selected with regard to the type of soil upon which the structure is to rest, and the allowable loads for materials of foundations beds according to Kidder's handbook are as follows:

Allowable Loads on Materials of Foundation Beds

Material	Pounds per square foot
Rock	30,000
Sand, gravel and boulders (compact)	10,000
Fine sand	4,000
Soft wet sand	2,000
Quicksand	1,000
Hard-pan (thick bedding)	8,000
Clay, ordinary	4,000
Clay, soft and plastic	2,000
Firm dry loam	5,000
Alluvial soils	1,000

All types and kinds of derricks have failed under working conditions, and generally speaking the cause of these failures can be attributed to eccentric loading of the structure, either because of one or more corners being low and throwing the compression strains upon the legs resting on these low corners to a greater extent than upon the other corners, or because the crown block has been shifted on its supports and the strains are not applied equally to all four legs in the derrick.

To prevent such failures extreme care should be taken in selection of the material to be used in making the piers upon which the derrick is to be erected.

If these piers must be made of wood because of some local condition, good timbers should be used for this purpose and not any cast off piece of lumber that may be found around the lease, for at the best the crushing strength of wood is very much less that the corresponding strength of steel, and it has been noted that steel derricks have been erected upon piers made up of miscellaneous pieces of wood, of varying thickness, and the sills leveled by using shims. These shims have been made from anything handy from a piece of shingle to an old piece of oil soaked board, and the bearing strength per square inch is so low that when the pressure of the loaded derrick is put upon it these pieces crush and the derrick is thrown out of line.

When the piers are made of concrete, the aggregates making up the mixture should be selected with reasonable care. Sand should be clean and free from vegetable matter and silt, and the rock used should be hard and not rotten, porous stones that will absorb a large quantity of water from the concrete mixture.

With poor aggregates concrete piers have been known to crush under the heavy loading to which modern derricks are subjected, and piers under steel jack posts and Samson posts failed and permitted the foundation bolts to be pulled out of the concrete.

THE use of cement is now so general and its properties so well known that there is no excuse for poor construction of foundations around the oil fields, but carelessness and apparent lack of this common knowledge has caused a lot of trouble in various fields, and these conditions usually occur in those fields where drilling is most active and derricks are erected in the shortest possible time.

The loading of derricks has been divided into four classes—the dead load, live load, load of impact and load of pulling.

The derrick itself forms the greater part of the dead load. A wooden derrick will weigh more than a steel one of like capacity.

The live load will be made up of the operating machinery to distinguish it from the load of hoisting and lowering pipe, tools and bailer. This live load will set up vibrations that are communicated to the foundations under the derrick and some authorities estimate that this type of load is 100 per cent greater than the weight of the machinery causing it, this weight to be added to the dead load as described above in estimating the pressure being applied to the piers.

There is another type of loading to which the derrick is subjected that is set up by suddenly starting and stopping the hoisting and lowering of pipe, casing and tools, which is termed the impact load and this has been estimated as from 400 per cent to 500 per cent of the dead weight of the material being moved.

This load caused by the quick acceleration and deceleration in handling drill pipe, casing and tools is under the control of the operator more or less, and many derricks have been caused to fail due to this form of loading when they would have stood without damage if the load had been applied gradually. Taking a run at a string of frozen casing by unwinding part of the casing line from the calf wheel before applying the power is a form of this type of loading, but it is not by any means the only manner in which this loading is applied to a derrick.

THE use of a swab, especially one without unloading valve, can throw upon a derrick terrific strains if the operator reverses his engine quickly after the flag on the line has reached the top of the casing. In some cases the swab is undoubtedly still sinking through the fluid and the line is suddenly tightened and the lifting of the swab started in the shortest possible interval, thereby causing undue strain upon line and derrick because of this rapid acceleration of the load from rest to full speed upward. Gradual acceleration of the load would only take a few seconds longer on each lift and the saving in strains on lines, derricks and engines would be appreciable.

The fourth type of derrick loading under operating conditions is the pulling load which varies greatly in the different fields, depending upon the weight and length of the strings of casing and the kind of formations through which they are set, but it has been estimated that the combined mechanical efficiency of the ordinary band wheel, calf wheel, and casing block is about 144 times the lifting force of the engine.

This would indicate that care and judgment must be used in applying this power, and with the steel derricks the driller has taken more to the practice of handling his engine from the engine house because there is very little warning before a steel derrick fails, while with the wooden structures there is considerable creaking and cracking of the timbers before the structure actually collapses.

To these four types of loading there is the wind load to be added, and the usual practice is to guy either the wooden or steel type of derricks with galvanized wire strand guys three or four being attached to each corner of the 122-foot combination type rotary derricks.

These guy wires should be securely fastened to a "deadman" buried in the ground and should not be attached to the first handy thing that comes to the notice of the rig builder, as is so often the case, such as an old stump or a small tree or bush which would not give any anchorage if the derrick was to be actually in danger of blowing over.

Within the last five years there has been a marked tendency to use derricks fabricated in the factory, and in Oklahoma the use of the turnbuckle type of derrick has been large, but now the all steel towers are being placed on locations for

deep drilling and as the tendency seems to be to go deeper for the oil of the future it seems only reasonable to assume that the allsteel derricks will be used in constantly increasing numbers.

It is estimated that about 50 per cent of the derricks in the Cromwell pool drilled in 1924 were of the fabricated type, and most of these were of the turnbuckle variety, but in the Seminole pool recently drilled are very few nailed wooden derricks as they were practically all of the fabricated type with the percentage of turnbuckle and all steel derricks about even.

WITH the tendency to drill to greater depths for oil, many producing wells now being over 6,000 feet in depth, and the more common use of the heavy rotary outfits for the boring of the holes through the upper sedimentary formations, with the twin cylinder steam engines and a battery of three or four boilers, and completion of the holes with heavy standard tool outfits, it seems safe to predict that the use of the all steel combination type derricks without relegs will become more general. While the combination or turnbuckle type of derricks have been used quite satisfactorily in drilling wells with average depths of about 4200 feet, to make structures of this type strong enough to meet the more severe requirements of the deeper holes would make them too costly, so the allsteel construction will be resorted to more frequently.

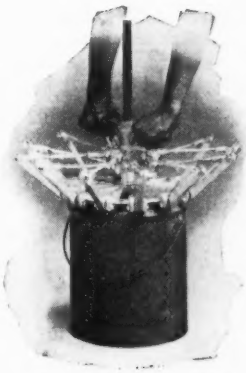
At this time it is quite common practice to double girt and sway brace a turnbuckle type derrick when it is used for very heavy loads and that is, of course, only a make shift arrangement and it is only natural to assume that customers will prefer to buy structures designed for their requirements in the first instance.

It is further considered quite probable that with the conditions of deep drilling calling for heavier equipment, there will be many changes in the details of the steel structures and within the next five years the present type of four legged derrick adopted direct from its wooden predecessor without material change in design, will be replaced with structural steel towers that will be designed strictly in accordance with good engineering practice to meet the changed conditions necessitated by the adoption of improved equipment for well drilling.

It is noted that the first structural steel towers for drilling purposes were carefully designed by competent engineers, who later, conceded their opinions in this mater to meet field requirements and produce a structure that could be more readilly sold.

Leak Proof

PATENTS PENDING



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NATIONAL PETROLEUM NEWS **1213 W. 3rd St. Cleveland, Ohio**

Pumping Equipment *for* Bulk Stations

By Herbert C. Osborne

ALMOST universally now the trend is away from the use of reciprocating and centrifugal pumps in bulk station plants and toward the use of rotary pumps.

The reasons for this are many, but seem to be largely the higher first cost of the older types, the greater floor space necessary, the need for greater mechanical ability to keep them in operation than that possessed by the usual bulk station attendant, and the low power efficiency of the sizes and types applicable to bulk station use. While only one principle is involved in either the centrifugal or reciprocating types, probably a hundred different principles applied to rotary pumps could be found in the patent office. Hence, every day, a new rotary pump appears on the market.

In no other line, therefore, is it more important to choose a product manufactured by a reliable concern that is a specialist in that line. The purchaser need not fear to buy the equipment sold by members of the Hydraulic Society. This Society is made up of 36 well-established pump companies who have joined together to establish standards and a code of ethics for the protection of the pump buyer.

Size

JUST as the trend of the times is toward rotary pumps, so the trend is toward larger pumps for the bulk station. "Unloading faster" is the up-to-date slogan as evidenced by an ever-increasing demand for 200-gallon per minute pumps by the operator who formerly purchased 100-gallon pumps; and for the 100-gallon size to replace pumps to deliver 50 gallons per minute.

Some oil companies have purchased pumps delivering 300 gallons per minute for bulk station use, and we are preparing for greater demands for this size during the coming season.

As to the proper size to use, it is largely a matter of how many cars a day must be handled, but even the operator handling only a car or two a week, finds the 100-gallon pump an advantage in hot weather when pumping gasoline is a serious problem at best. The faster pump "gets the car off" before the sun has had a chance to heat the product to a point where the slightest vacuum created by the pump, would form vapor and cause trouble. This trouble will be discussed more fully later on in this article.

Power

AFTER type and size, the power to drive the pump must be considered. From 70 to 80 percent of bulk station units are electric driven, but some oil companies continue to use gasoline engines, even where electricity is available for the same reason that restaurant proprietors don't go out to lunch.

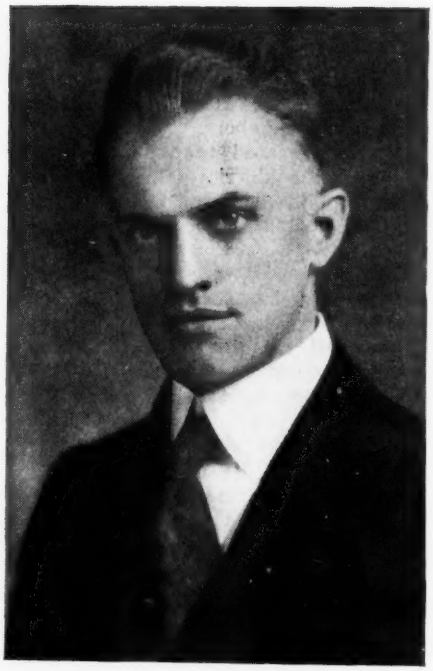
Either kind of power has a fire-hazard of which the old steam power was not guilty, but the hazard is practically eliminated by means of a wall built up between the motor or engine, and the pump. Some companies employ the fire-wall only for motors having commutators; that is, motors, such as direct current or single phase which have brushes, and therefore can spark during normal operation. Others use the fire-wall for all motors and engines, their contention being that a broken or loose wire can cause the fatal spark. Undoubtedly, a hazard exists, and a fire-wall is strongly recommended for all bulk station pump-houses.

The size of the power unit depends, of course, on the difference in elevation between the bottom of the car and the top of the storage tanks; and the length and size of pipe lines; also such restrictions to flow as elbows, valves, or a strainer. When unloading oil, viscosity also has to be taken into consideration.

Assuming that the pump has a capacity of 90 gallons per minute, is within 60 feet of the car, and 30 feet of the vertical storage tank, that there is an overhead unloading rack, no screen, 2-inch piping reasonably direct; then a 3 horsepower motor or engine is large enough, and anything larger means higher first cost and higher operating cost, due to lower efficiency and lower power factor.

To figure horsepower, the following procedure is standard practice:

1. Count elbows and valves as equivalent length of straight pipe so far as friction is concerned. (See table No. 1).
2. Add this length to the actual length of straight pipe.
3. Get the "friction head" by means of table No. 1. (Friction head is the height of a column of water sufficient to force the capacity of the pump through the pipe-line of the size and length in question when placed horizontally.)
4. From tables get the "water horsepower" or multiply the gallons per minute by the head in feet and divide by 4000. This gives the "water horsepower."
5. Multiply by the density of gasoline, or take three-fourths of the water horse-power.
6. Divide by the efficiency of the pump unit or roughly, multiply by two.
7. Use the size motor or engine nearest above the figure obtained.



HERBERT C. OSBORNE

Mr. Osborne is a graduate of Dartmouth College and the Thayer School of civil engineering, specializing in hydraulics. For six years, he was a research mechanical and hydraulic engineer for the U. S. air service at its experimental plant at McCook Field, Dayton, O., and for the past three years, has been chief engineer of the Blackmer Rotary Pump Co.

Transmission

BELTING the power unit to the pump was once the vogue, but every year fewer belted pumps and more pump units are used by the oil marketer. The motor or engine is mounted on a cast-iron or steel base with the pump and connected to it, usually through gears or chain drive. The best rotary pumps are slow speed machines, and, therefore, have to be driven by speed-reducing

gears when electric motors are used for power. The disadvantage to gearing is the noise and this objection has been largely removed by the use of Bakelite for the motor pinion.

Low speed machinery in bulk station plants is an advantage as there is less danger of fire because of bearing seizure due to lack of lubrication.

Installation

THE "hook-up" connecting unloading rack, pump unit, storage tank, and truck loading rack is a matter of much argument, and many different methods are in use. We believe that in most cases the "hook-up" shown in the accompanying drawing is the best.

The overhead unloading rack is shown in this ideal layout, not because it is the best or cheapest, but because more and more, it is becoming unlawful to unload tank cars from underneath. Undoubtedly, there is a fire hazard when unloading from underneath for at least two reasons. The main hazard exists when another freight car bumps into a connected car, breaks the hose and allows a 4-inch stream of gasoline to run into the city sewer. Also, in northern cities in the winter, the sump at the bottom of the car sometimes freezes, as all the water in the car has gathered into this sump. The quickest way to get the car connected is to melt out this ice, and the blow-torch is the most convenient. It isn't necessary to explain why this is a fire-hazard.

Still, there are many adherents of underneath unloading, and there are conditions under which pumping off the car from overhead is impractical.

The service department of any pump company specializing in gasoline pumping equipment is familiar with the complaint in hot weather that the "pump will take off only half the car and then she lays down, but it worked all right last spring."

While not all complaints that the car cannot be emptied using an overhead rack can be laid to hot weather, yet the majority are traced to this cause. The explanation is, that when the car is full, the pump has to raise the liquid only about two feet besides overcoming the pipe-line friction in the suction line. Let us say that a vacuum gauge at the pump reads 5 inches. Now suppose after a time that the gasoline falls three feet in the car and then the pump refuses to take off any more.

What has happened? In the first place, the vacuum on the liquid in the pipe has increased to 7 inches and probably the temperature of the liquid has also increased.

AT THAT temperature, and with that vacuum, the particular gasoline in question vaporizes to some extent in the pipe, and the pump has to handle combined vapor and gasoline. The capacity of the pump falls for two reasons. In the first place, if the pump displaced the same volume as before, the *weight* of gasoline would be much less because part of the volume is vapor.

But the pump does *not* displace the same volume because the "slippage" has increased. Naturally, there is some internal leakage from the discharge to the suction side in any pump, and this leakage, called "slippage", depends on the fluid being pumped. For example, heavy oils do not slip hardly any, while gasoline "slips" more than water, and gasoline vapor has a very high rate of slippage. Slippage increases as the pump wears, and an old pump in need of repairs, may refuse to unload a car at all on a hot day.

From the above, it is evident that there are advantages to unloading the car underneath, as the liquid always flows to the pump, and the last gallon can be taken off easily.

The tendency, however, is toward overhead unloading and the advantages are, we believe, greater by this method. Nevertheless, it must be recognized that the best of pumps in the best of condition will fail to unload completely from overhead a car of highly volatile gasoline on a very hot day through suction lines the same size as the pump, and much over 100 feet long. At times, therefore, a law requiring unloading a car from overhead is going to be irksome.

APPARENTLY, the best way to do is to leave a connection at the base of the unloading rack, in order to use the underneath method if occasion requires.

The next part of the hook-up diagram to be described is the suction strainer at the lower end of the suction pipe in the car. This fitting is very seldom used, but has merits which warrant a more popular recognition. It has two valuable features, the strainer to stop stray rivets from wrecking the pump, and the large diameter, flat casting, which allows the entire area of opening to be close to the tank bottom. Also, the suction pipe can be let down to the bottom of the car and left there during the entire unloading, without the necessity for blocking up the pipe and lowering it later for the last 100 gallons or so.

The advantage of the low opening

Table I

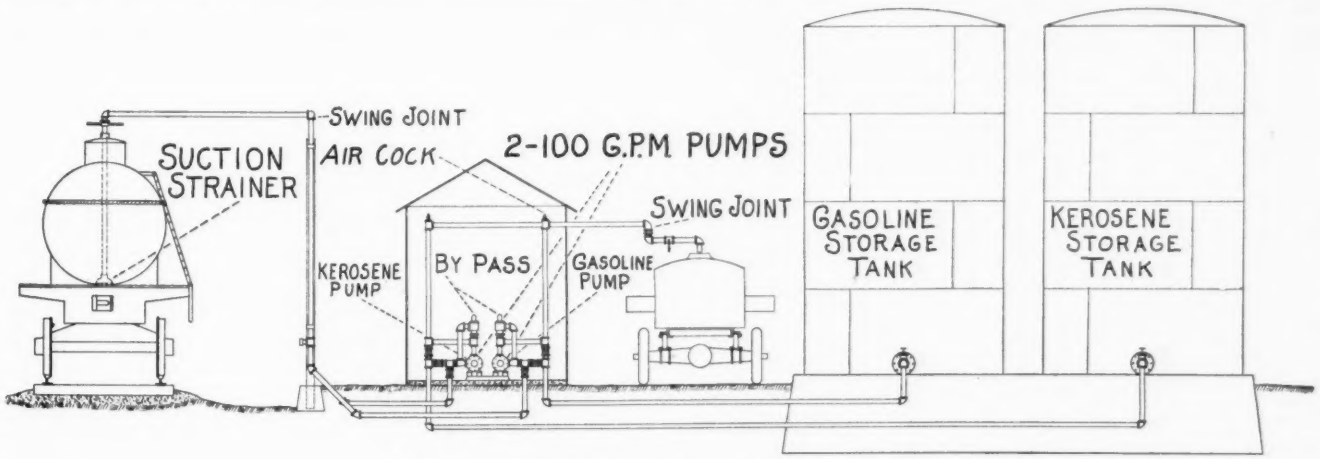
Friction of Water in Pipes

Loss of Head in Feet Due to Friction, per 100 Feet Ordinary Iron Pipe.
70 % of these values may be taken for a gasoline pump installation

Gals per	Size of Pipe					
per min.	1¼"	1½"	2"	2½"	3"	4"
25	16.6	7.8	2.73	0.92	0.38	.....
30	23.5	11.0	3.84	1.20	0.54	.....
35	31.2	14.7	5.1	1.72	0.71	.....
40	40.0	18.8	6.6	2.20	0.91	0.22
45	50.0	23.2	8.2	2.80	1.15	0.28
50	60.0	28.4	9.9	3.32	1.38	0.34
70	113.0	53.0	18.4	6.2	2.57	0.63
90	.....	84.0	29.4	9.8	4.08	1.05
100	.....	102.0	35.8	12.0	4.96	1.23
120	.....	143.0	50.0	16.8	7.0	1.71
140	.....	190.0	67.0	22.3	9.2	2.23
160	.....	.....	86.0	29.0	11.8	2.85
180	.....	.....	107.0	35.7	14.8	3.55
200	.....	.....	129.0	43.1	17.8	4.37
220	.....	.....	154.0	52.0	21.3	5.26
240	.....	.....	182.0	61.0	25.1	6.22
260	.....	.....	211.0	70.0	29.1	7.20
280	.....	.....	.....	81.0	33.4	8.23
300	.....	.....	.....	92.0	38.0	9.38

FRICTION OF WATER IN 90° ELBOWS
Equivalent Number of Feet Straight Pipe

Size of elbows, inches	1¼	1½	2	2½	3	4
Friction equivalent feet straight pipe	8	8	8	11	15	16



Hookup of pumps and piping at a modern bulk station

is apparent, if we analyze what happens when the last few hundred gallons are taken off. First, consider the ordinary suction pipe bevelled at the bottom so that the area of opening will not be reduced when the pipe is lowered to the car bottom.

When the gasoline stands perhaps 6 inches in the car, the flow from the ends of the car towards the middle becomes noticeably slower and continues to get slower as the depth is increased. This is a principle which the hydraulic engineer explains by saying that frictional resistance increases as the ratio of wetted perimeter to cross-sectional area increases.

At the center of the car, let us suppose that 100 gallons per minute are flowing to the pipe opening. As the gasoline level in the car lowers, a point is finally reached where the flow from the ends towards the center is less than 100 gallons per minute, and then a depression in the level occurs at the pipe and air is sucked into the opening, reducing the capacity of the pump or even making it necessary to reprime the pump if it is in need of repairs.

THE use of the suction strainer fitting is to make it possible to take off more of the car before "sucking air." When the pump "sucks air," it not only increases the time of unloading, but any pump will wear out faster when it is not "flowing full," that is, when its displacement is greater than the amount of liquid flowing.

Some rotary pumps, due to high slippage caused by low-grade manufacture or by wear, when they "suck air," have to be reprimed, so that in this case, the fitting above described is particularly valuable.

Referring to the hook-up diagram again, the size of pipe-line is not given because it depends for a given pump capacity, upon the distance between car and pump and between pump and storage tank. When unloading oil, the size of line also depends upon the viscosity of the oil.

Calculation of the size of line necessary for a given installation is sadly neglected in most instances and yet it directly affects the pocket-book of the bulk-station owner.

One very recent case came to the writer's attention in which a 100-gallon per minute pump was put on a 2-inch suction line 300 feet long. From table I, note that 100 feet of pipe for 100 gallons per minute has a frictional resistance equivalent to a head of 36 feet of water. Three hundred feet of pipe would have a pressure drop three times as great, or 108 feet of water. Considering that these tables are for water, we can in our case for gasoline take 70 percent of this value which gives a friction head of 76 feet.

A suction greater than about 30 feet is impossible and over 15 feet is impractical on gasoline, hence, either a smaller pump or a larger line is necessary.

In the case in question, the pump *tried* to get 100 gallons per minute but *could* get only 50 gallons per minute as can be readily determined in the same manner as above, from table I. The result was a badly acting pump and a short-lived one. A 50-gallon per minute pump would have given just as much capacity, cost less, run more smoothly, and lasted longer. If 50 gallons per minute is not fast enough, it did no good to put on a bigger pump, the only solution being to shorten the suction line or increase the pipe-size.

We have considered just the suction side of the pump. As for the discharge line, it is not a matter of impossibility because of law of nature, but merely a matter of the monthly bill for power and keeping below the maximum pressure recommended by the pump manufacturer. Therefore, a long discharge line is not so serious as a long suction line. However, cases are brought to our attention frequently where a 2-inch line was poor economy, and the 3-inch line could have been paid for in a year by the increase in current cost because of the smaller type.

As an example, take a 100-gallon per minute pump with a discharge line 800 feet long. From table I the pipe line friction of a 2-inch line would be 200 feet, and that of a 3-inch line, only 30 feet. The added horsepower necessary in the case of the 2-inch line is, therefore,

$$\frac{(200-30)100}{4000} = \frac{17000}{4000} = 4\tfrac{1}{4} \text{ H. P.}$$

At 50 percent efficiency, 8½ horsepower more would be necessary for the 2-inch pipe line. Disregarding the extra first cost of the larger motor, the extra monthly cost at 3 cents per k. w. h. running the pump 24 hours a week would be $19.75 or $237 in a year. Three-inch pipe costs the oil jobber about $37.50 per 100 feet and 2-inch costs about $18. The difference in cost of 800 feet of line, therefore, is $156. Of course, valves and fittings must be considered also, but a year of the higher power cost would easily pay for the 3-inch installation.

UNFORTUNATELY, pipe-line friction is too often considered of little importance or completely disregarded, and it is hoped that the above comparison will open the eyes of oil jobbers to the need for making this very simply calculation when planning their bulk stations.

Referring again to the hook-up diagram, you will note that an air-cock is placed at the top of the discharge line, above each pump. This is necessary to keep a pump from becoming "air-bound" or "vapor-bound." One frequently hears of an "air-bound" pump but the cause for it and how to overcome it are often not understood by the pump user.

Air in liquid rises upward, therefore, draining air out of a pump or line is just the reverse of draining liquid. Hence, to drain air, an air-cock must be placed at the highest point of a line. It is believed erroneously by many people that the air will be carried out of a high spot by the stream of liquid. The stream simply follows the wall, passes around the air, leaving an elongated air bubble which surges back and forth. It is true that this bubble can do no harm unless it extends into the pump and then it displaces that much liquid, thereby reducing the capacity of the pump per revolution by the volume of air "bound" in the pump.

A simple pet-cock at the uppermost part of the discharge line opened when the pump is started up and closed as soon as a full stream of liquid appears, is a convenient and effective solution to this difficulty. The writer has on several occasions used this device when called out on a trouble job and in one case, after nearly doubling the capacity, was told by the owner that in the future, he would use "lots of pet-cocks."

Operation

Following are some simple rules for operating rotary pumps used for bulk stations.

Priming:

If the pump does not discharge liquid after operating a minute, stop the pump and prime it by pouring gasoline into the discharge of the pump. (It is advisable to leave a tee or Y connection in the pump discharge pipe for this purpose).

Stuffing Boxes:

A slight flow of liquid from the stuffing boxes when pump is running preserves the packing but because of the high value and inflammability of gasoline, glands must be tight, but the packing should be replaced often to prevent the packing scoring the shaft.

Suction Piping:

The suction piping should be as direct and short as possible, and of a diameter at least one size larger than the pump connection, except when the lines are very short. Length and size of suction pipe are determined by the maximum allowable total suction lift,

which should never exceed 15 feet, friction included.

Pipe should be laid out so that air pockets are eliminated, or else air-cocks used at the high points. Pipe should be tested with pressure for leaks.

Discharge Piping:

A by-pass line containing a relief valve should be installed between pump and discharge gate valve to protect pump in case of accidental closing of this valve. The by-pass line should be piped back to the suction line. The relief valve should be set to a pressure slightly above the maximum pressure desired at the pump discharge and not more than 10 per cent above pressure for which the pump is sold.

Locating Trouble

No Gasoline Delivered:

(a) Pump not primed.
(b) Suction lift too high. Check with a gauge at the pump suction.
(c) Wrong direction of rotation.

Not Enough Gasoline Delivered:

(a) Air leaks in suction or through stuffing box.
(b) Speed too low.
(c) Suction lift too high.
(d) End of suction pipe not immersed deeply enough.
(e) Piping improperly installed permitting air or gas to pocket in the pump.
(f) Mechanical defects:
Pump damaged.
Pump badly worn.
Packing defective.

Pump Works for a While and Then Quits:

(a) Leaky suction lines.
(b) Suction lift too high.
(c) Air or vapor in the liquid.

Pump Takes Too Much Power:

(a) Speed too high.
(b) Liquid viscous.
(c) Suction or discharge line obstructed.
(d) Mechanical defects.
Shaft bent.
Rotating element binds.
Stuffing boxes too tight.
Misalignment due to improper connection to pipe lines or installing on foundation causing spring in cylinder or base.

HOUSTON, Sept. 15.—Southern Gas Co. has awarded contract to N. A. Saigh of San Antonio for the laying of 55 miles of 8-inch pipeline north from San Antonio to New Braunfels and Seguin. The contract price is roundly $500,000 for the main line and the distributing subsidiaries.

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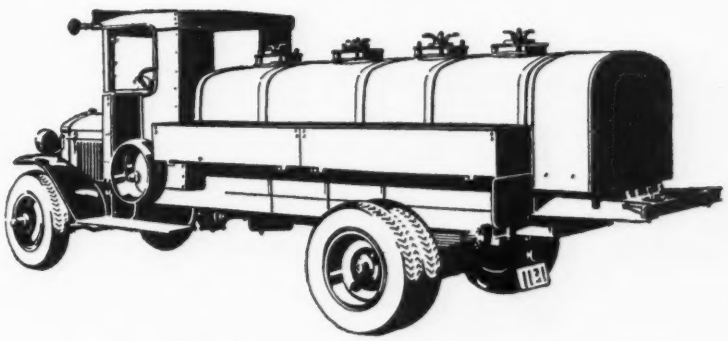

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OIL & GASOLINE TANKS & FITTINGS

Send for Tank Bulletin No. 105

QUAKER CITY IRON WORKS

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Installation, Operation, Maintenance Of Filling Station Air Compressors

By Lawrence A. DeMarsh

SATISFACTORY air service depends upon having an air compressor of sufficient capacity to do the job. A perfect installation combined with proper maintenance facilities will not make a small compressor do the work of a big one. Air compressors are proved merchandisers which can be used for many years and it is poor economy to select one that is too small for the job.

To select the right size compressor a recognized standard of measurement should be used. Many installations have proved inadequate when judged by the size of the tank, the size of the motor or the bulk of the unit. While due consideration must be given each of these factors, the basic factor of measurement is compressor displacement. To arrive at the displacement of the compressor the following formula is used:

Piston Area Piston Stroke
*sq. in. x in. x R.P.M.
x No. Cylinders ÷ 1728 = Cu. Ft. Displacement.

*In two stage compressors the area of the low compression cylinder only is considered.

The actual capacity—volume of air delivered—will not equal the displacement, but in the best of compressors, capacity will be less than displacement. When the actual air consumption at a station is determined by summing up the various uses for air, we suggest selection of an air compressor with a displacement twice the actual air required. For inflation purposes allow about two cubic feet displacement for each busy air line. The amount of air required to operate gas pumps and other equipment can readily be ascertained by referring to the printed matter of the manufacturer whose equipment is to be used. It must be considered here that the tank will take care of a very large withdrawal of air only momentarily. For equipment used only intermittently, tank storage can be depended upon within the limits of its volume, but for equipment used steadily, the air requirements should be considered in relation to the displacement of the pump.

When air was used only for free air service it was easy to select the proper compressor from experience. The use of many profitable pneumatic appliances, such as air actuated gasoline pumps, pneumatic oil dispensers, high pressure lubricating systems, spring oiling systems and pneumatic hoists, has brought about the need for a more careful selection of filling station air compressors.

L. A. DeMARSH

Mr. DeMarsh was graduated from the University of Michigan, college of engineering, in 1920. After a year of research work at Michigan he became connected with the Brunner Manufacturing Co., Utica, N. Y. as territorial sales representative and later as branch manager. At present Mr. DeMarsh is manager of the industrial department with headquarters at Utica.

Assuming that the compressor will be an automatic assembled unit, discussion will be confined to this type of installation.

With this type of equipment the prime factor of installation is piping. The pipe used should be of good quality, at least ⅝-inch in diameter, with all joints absolutely air tight. Litharge or white lead joints are recommended. The joints should be tested under pressure for leaks with soap solution, or the use of volatile odorous oil, such as peppermint oil, fed to the intake valve of the compressor used for test. Any leaks will be detected by the odor issuing from the joints leaking. This precaution will prove economic, for it will eliminate expensive tearing up piping to correct leaks when they are discovered later.

FROZEN air lines are not uncommon during winter months in cold regions. Simple precauion will eliminate this difficulty and save station operators much inconvenience, as well as expense. Methods suggested include:

1.—Piping should be laid under ground below freezing zone.

2.—Pipe pockets and multitude of bends should be avoided.

3.—Ideal installation of piping involves the use of drainage points to which the pipe will slope. Drain cocks should be placed at these points.

4.—Frozen pipe is apt to burst. To repair such pipe lines is expensive enough under any circumstances, particularly so when they are laid under concrete. Much of this expense can be avoided by laying the air pipes within a pipe of larger diameter. This method results in a double advantage. The air insulation within the larger pipe minimizes the possibility of freezing. On the other hand, ruptured or leaky lines can be removed for repair without tearing up concrete.

5.—The danger to pipe lines during the winter season arises from freezing of moisture condensed in the pipe lines. It is possible to trap much or most of the moisture before it enters the pipe lines by installing an air strainer or air conditioner near the tank outlet.

Adequate attention should be given to the location of the compressor unit. No compressor can be expected to give a maximum degree of satisfactory service if placed in a cold, damp or dusty location. To facilitate repairs, the room where the compressor is located should be lighted with a light bulb placed directly over the machine and the machine should be installed far enough away from the walls to permit convenient adjustments and repairs. As a general rule an inaccessible compressor is usually neglected. We suggest, furthermore, that belt side be placed next to the wall and that the outfit be on a level, bolted firmly to the floor.

A number of oil companies have found that their compressor installation will attract favorable attention and trade if installed in a conspicuous place. Where this is done,

it is highly necessary that the attendants keep the compressor looking trim and bright. This policy has another advantage. The compressor will not suffer from want of attention when it is installed in a prominent location.

The electric wiring is likewise an important part of the installation. Perfect motors improperly wired will cause no end of trouble. Even on the smallest units it is never advisable to connect the motor to the light circuit. Where possible, arrangements should be made for a special power line with the power company. When this cannot be had, we suggest that the electric line to the compressor be connected direct to electric service at the meter, where voltage is highest. It is always desirable to install an emergency knife switch on the wall not far from the compressor motor.

THERE is no need to discuss the theory of compressor design or engineering. Station owners are interested generally only in factors that insure satisfactory operation and service. A few simple instructions that will insure such satisfactory service are supplied by the manufacturers with the equipment at the time of delivery. These instructions usually deal with the following points:

1.—Oil regularly.

2.—Open knife switch when station is closed.

3.—Continue check for wasteful leaks.

4.—Drain tank of oil and moisture.

Most air compressor trouble can be traced to the lack of oil or the use of the wrong grade of oil. Safe operation, freedom from carbon deposits, elimination of frictional losses and prevention of air leakage past the pistons and rings depends largely upon the use of a lubricating oil with high flash point, minimum content of free carbon and vaporizing tendencies reduced to a minimum.

Too much oil and the wrong grade of oil cause the formation of a carbon deposit on the discharge valves, interfering with their automatic operation. Foul valves ultimately fail to close, permitting the leakage of compressed air back into the compressor, causing in turn, very high temperatures. Small pieces of excess carbon deposit will pass into the pipe lines and when they lodge on the seat of the check valve may cause the check valve to leak. For these reasons, definite instructions designating grade of oil to be used should be given to the station attendant.

When the station is closed the emergency knife switch should be opened, shutting off the power to the compressor. A stolen air chuck, a cut air line or any other condition causing loss of air will operate the compressor continually until the condition is discovered and remedied.

SHOULD the compressor be operating during a period of severe voltage fluctuation—a condition quite common during the night, early morning, Sundays and holidays—motor trouble is very apt to develop. While this trouble may be nothing more serious than a burned out motor—in itself an item of expense—it is quite possible the burning out of the motor may cause a very disastrous fire. Motors are guaranteed only for operation on voltage that is within 10 per cent of indicated rating.

Air leaks are very expensive and should be attended to at once. In case the compressor appears to pump slow or to be pumping too often, a leak is probably the cause. The need for prompt attention to even a small leak becomes apparent when the cost is considered. An opening as small as 1/64-inch in diameter will consume over 20,000 cubic feet of air per month at the average pressure of 125 pounds carried for filling station service. This represents many hours of useless wear and tear on the compressor. In addition, one such leak will cost $3.70 per month for electricity, based on a rate of 10 cents per kilowatt hour.

To insure clean air to the lines the compressor tank should be drained once a week. Any device installed to trap water and oil should likewise be drained frequently, in some cases daily.

During the first year or two a compressor, if carefully selected, properly installed and given adequate attention, should require no replacement of parts and very little maintenance expense, except for oil and electricity.

Oil companies, irrespective of their size, should have a maintenance department to suit their conditions. Results obtained from the compressor equipment depends upon regular inspection by a competent mechanic who understands the function of the working parts of the compressors. Varying results are obtained from users of identical equipment. These results are brought about by the proper or improper functioning of the maintenance department, which may be a part time job for one man or a full time job for a crew of men, depending upon the number of stations operated.

THE following factors should be checked regularly by the inspector:

1.—Check and instruct attendants on operation.

2.—Make necessary adjustments.
   a. Correct check valve leaks.
   b. Correct all leaks in piping and equipment.
   c. Adjust belts.
   d. Clean and adjust all valves on compressor if not functioning correctly.

3.—Inspect machine for worn parts.
   a. Belts.
   b. Bearings.
   c. All valves.
   d. Rings.
   e. Gaskets.

4.—Check motor.
   a. Replace brushes when worn.
   b. Keep commutator clean.
   c. Check for proper fuses.

5.—Recondition compressors as required.

While it is not good policy to have the station attendant tinker with the outfits, it is important that he be instructed carefully on all points pertaining to the satisfactory operation of the compressor. The cleanliness of the compressor is a pretty sure indication of the care it receives. A dirty compressor invariably indicates to the inspector that the outfit is being neglected.

In all cases, it is advisable to have the instruction card furnished by the manufacturer placed on the wall near each compressor. Some oil companies have these instructions framed in order to keep them from getting lost. These simple instructions at the disposal of the attendant will save, in many instances, costly trips for the mechanics and aid greatly to maintain uninterrupted air service.

NEW YORK—A new type of conveyor furnace without pans or trays, for the annealing or heat-treating of miscellaneous metal products, is described and illustrated in bulletin No. 280 just published by W. S. Rockwell Co., furnace engineer and contractor, with headquarters at 50 Church St. here.

The absence of pans or trays effects a savings in heat otherwise lost, the bulletin states, by avoiding high and closely packed charges, labor of handling trays and providing more comfortable working conditions for operatives.

Oil, gas or electricity may be used for generating the heat. An alloy metal conveyor operating within the furnace permits charging at random and movement, without distortion, through the furnace and delivery to a shower or bath for cooling. Individual exposure permits uniform application of heat to each piece and uniform cooling, the company claims.

Electric and fuel furnaces for continuous heat treating are described in its bulletin No. 284. The various types of these furnaces have been developed to meet modern requirements for better quality and lower cost.

Making Free Air Service Show a Profit

By Harry Haudenschild*

HARRY HAUDENSCHILD

IT IS surprising to note the lack of attention that is given to the installation of the free air service, at the average filling station. Every day we see fine new stations being erected, expensive equipment installed, but little or no attention paid to the piping up of this equipment. Time after time, the writer has stopped at new stations where construction work was going on to observe the installation of the underground piping, particularly on the air service lines.

I have talked with the construction superintendents, together with plumbers and mechanics who were actually doing the work, and it is surprising to learn the few men doing this work who know anything about the laying of such pipe lines, or the action of compressed air.

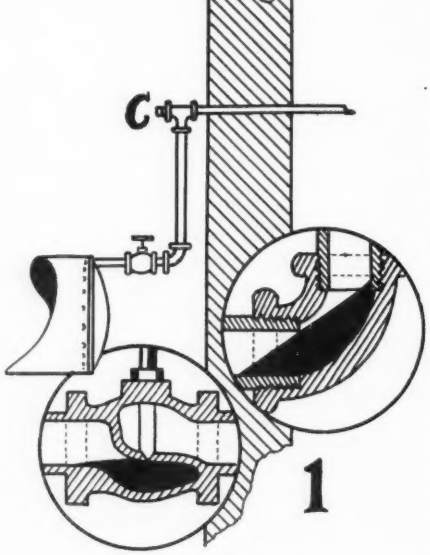
Most of these fellows will tell you there is no need to lay the pipe so it drains, because air flows through it, and there is no water in air. The result is, the air service at the average filling station freezes up in winter, and in many sections of the country station owners take it for granted that the air service will freeze up. They expect it and are not surprised or disappointed when it happens.

The free air service is one of the best mediums available for bringing new business into the retail filling station. Correct inflation of pneumatic tires is today given more consideration by motorists than ever before. Balloon tires make this necessary, and motorists are well informed as to the necessity of keeping their tires properly inflated, if they are to get satisfactory mileage out of them. With the average tire pressure ranging from 25 to 40 pounds, a matter of 5 to 10 pounds makes a big difference. With the old time high pressure tires, from 10 to 15 pounds difference in pressure did not make so much difference, and tire inflating was not a serious matter. The air service is used from three or four times as much as it was in the old days when high pressure tires were used.

Practically every station today has free air, so why not make this air service pay you a profit? You spend good money for the air compressor, which is usually installed in the rear of the station, or in the basement, where the station has a basement. Out on the business or contact end of the air service, is where the average station owner falls down and tries to cheapen his air service. Right there is where it pays to spend a little more money. Motorists, as a general rule, appreciate the free service that is rendered them, and are keen to observe the installation of better equipment to dispense this free service for their benefit.

When you are putting in your air service, install it with the idea in mind that it is to be 24-hour service, every day in the year. The additional cost is rarely more than a few dollars between a good job and a poor one. Water forms in all compressed air lines, so be sure to use galvanized pipe for all underground lines. We recommend the use of galvanized pipe for all air lines, whether they be under or above ground, and it pays to use half-inch pipe, because the smaller sizes clog up with sediment and pipe scale, especially at the fittings and valves. (See Figure 1.) In installations where you use several outlets, the smaller size pipe does not supply a sufficient flow of air to operate the modern air dispensing machines.

Always run your air lines with sufficient fall so they will drain and a water trap should be installed in every air line, at the draining point, with a blow-off line leading to the surface so that line can be drained at frequent intervals. (Illustrated in Figure 4.) Where the air compressor is installed in the basement, always put a tee fitting just inside the foundation where the line runs throughout into the ground. (See Figure 3 at C.) A pipe plug in the end of this tee permits access to the lines, and often will save you the cost of a dig-up and in some instances the relaying of concrete, in case something should happen to the air lines.



Where the compressor is mounted in the rear of the station, run the pipe from the top of the air tank down into the ground, inside of the station by all means. (See Figure 3.) Do not run it out through the side of the station and then down into the ground, unless you cover it properly with a sufficient amount of insulation to prevent its freezing in winter.

Blowing the warm air out of the compressor tank through this cold section of pipe if left exposed to the outside, will condense the air into water very rapidly, and unless you have proper trapping facilities at the end of the lines, or have them buried deep enough to prevent freezing, your air lines will certainly freeze up in cold weather.

The best way is to put the air lines down below the frost line, and your local plumber can always give you the proper depth. In event you do not lay the lines below the frost line, be sure to lay them with sufficient fall to the draining point so as to prevent any possibility of water standing in them, and freezing. When the lines are put in, care should be taken to see that they are not allowed to sag and form pockets

*President, The Air Scale Co.

The New Larkin-Thuro 5 in 1 Compressor-Flusher

A Real Merchandising Unit

This new piece of Larkin-Thuro equipment is so far advanced—so superior—to any similar equipment in design, speed and performance that there is nothing in the field of lubricating equipment to compare with it.

It is the only Compressor offering five distinct services and at the price you are asked to pay for a less complete, less efficient device rendering not more than two services.

Five Operations

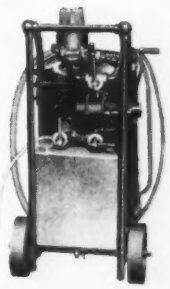
To see this New 5 in 1 Compressor-Flusher is to buy it. A turn of the handle in one direction and the old lubricant is removed by vacuum from Transmission or Differential: a valve is opened and it is thoroughly flushed; a turn of the handle in the opposite direction and it is refilled with fresh lubricant at a speed of five pounds in fifteen seconds. Then with the same machine the springs are sprayed and the motor cleaned. Five separate and distinct operations without lost motion or the loss of a moment's time by the operator.

Meter Equipped

Another appreciated feature is the meter registering the lubricant as it goes into Transmission or Differential accurately by pounds and half-pounds with a master dial reading to 99,999 pounds. This meter prevents any possibility of mistakes on the part of the operator and arguments on the part of the customer.

Large Capacity

In addition to rendering five distinct services this 5 in 1 Compressor-Flusher adds other desirable features not found in other equipment. For example: there's the feature of large capacity. Equipment of ordinary capacity has a habit of becoming empty just when the station is the busiest. Not this equipment however. With a capacity of 100 pounds of transmission lubricant this Compressor, with only an occasional re-filling, is always ready for service.



Rear view of 5 in 1 Compressor-Flusher showing Auxiliary Tank and Control Valves.

Auxiliary Tank

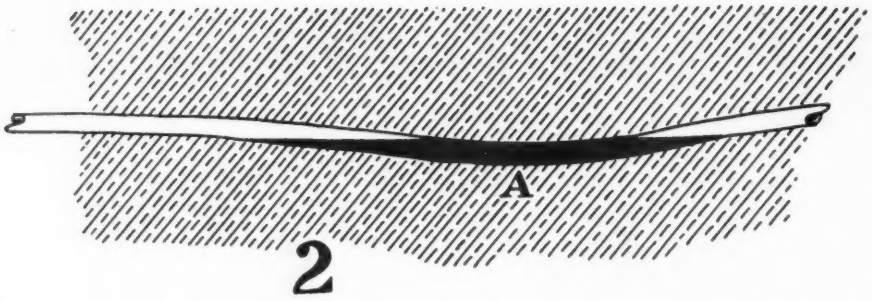
A 5-gallon tank for kerosene, flushing oil, or penetrating oil is mounted on the rear of the carriage for gear flushing, motor washing and spring lubrication. Forced thru an auxiliary 26" nozzle equipped with Lunkenheimer control valve, the spray of kerosene or oil comes out with sufficient velocity to easily reach the hard-to-get-at places.

This equipment will increase lubricant sales by selling 3 to 10 pounds where one or two pounds were formerly sold, and will reduce servicing time. Ask your Jobber for this 5 in 1 Compressor-Flusher or write direct to us for complete information.

LARKIN High Pressure "Puts the Grease where the Squeak Is" Lubricating System THURO

The Larkin Automotive Parts Co., Dayton, Ohio

Sell the Car owner on Complete Transmission and Differential flushing and filling with new lubricant every 2000 miles.



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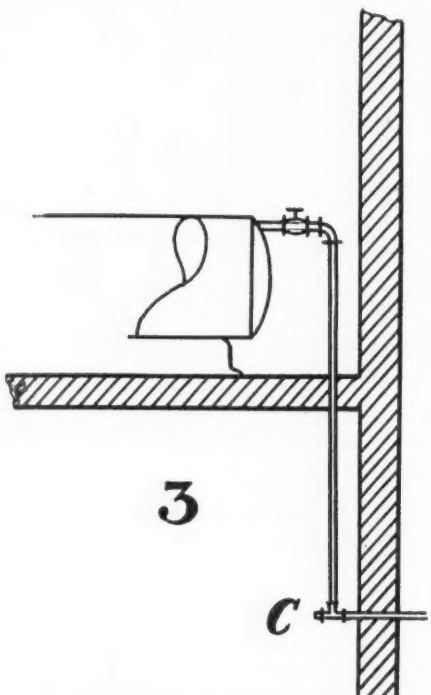
where water will accumulate and freeze. (See Figure 2). It is a common thing to see workmen filling the trench in which the air lines are laid, standing on the pipe while they are filling and as a result of their weight bending it down, oftentimes



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from two to four inches, tamping the dirt on top of this sagged line. When the line freezes up they can't understand why it should do that, when a few minutes' care on the part of the construction superintendent, or his foreman when the lines were being laid would prevent all of this trouble later on.

The installation of air service costs money. It is a service that you must provide, so why not give it the proper attention, and see that your air service is put in first class, from the compressor to the air vending machines? Don't overlook the possibilities of this free air service. It pays to install plenty of air outlets, and attractive air dispensing machines. While their first cost is higher they will usually pay for themselves the first year in the amount of new business they will bring to any station where they are installed, especially if a station is manned by live operators who will take the time to get acquainted with motorists who stop to use the air service.

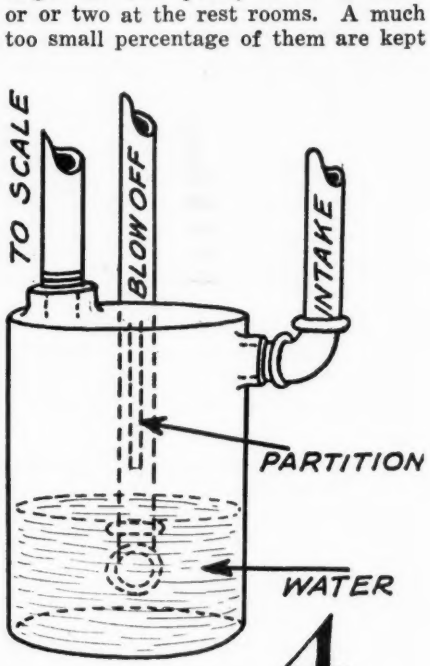
A big percentage of motorists do not carry an air gauge and they don't like to ask for the loan of one from the station operator. If your air service requires the use of a gauge, it will pay to have your operators step up promptly to motorists stopping at the air service and offer to inflate their tires for them, or tender the use of a gauge in case the operator is busy and can not wait on the air customer immediately. This added courtesy might cost a few more gauges, but in the end it pays.

Watch the condition of your air compressors, especially after they have been in service a year or more. See that the rings are tight, as otherwise the oil leaks through into the air tank, and the first thing you know you will be blowing oily air through your lines, which if not trapped or filtered, will find its way into your customer's tire. Drain the water out of your air tank once a month regularly, oftener if necessary. Every air line should be trapped, so the water and oil can be drawn off, and this should be attended to at least once or twice a week. You will find motorists are very appreciative of better air service, and will go out of their way to patronize stations so equipped. Provide enough air outlets, so your customers don't need to wait. If they drive by your station and see the air service busy, what happens, they just drive on to the next station, and the chances are, while they are there, fill up with gas and oil, and you lose the business.

Most motorists today take it for granted, that gasoline sold at the up-to-date filling station is good. Please remember, better service, prompt and courteous attention, with up-to-date facilities count more with motorists today than anything else. It prompts them to turn in to this, or that station and they will drive out of their way several blocks to patronize certain stations where they do render this better service.

Adequate air service and provisions for enabling the motorists to inflate their tires accurately is perhaps the outstanding single service that will attract motorists, and once they are induced to stop, your operators have the opportunity of making customers out of them. If they don't stop, you don't sell them, but once they stop they will probably buy, especially if your service pleases them.

In concluding, let me say, that your free service is your best salesman. You must have it. You make an initial investment of a considerable amount of money in providing this free service, and you should keep it up in the best possible condition. Consider it as an investment. Make it pay you a profit. This does not apply only to the air service. I might at this point, throw a stone or or two at the rest rooms. A much too small percentage of them are kept



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clean and in shape to use. Most of them we all know, are in terrible condition. Keep them clean and inviting. Make your station an outstanding one, that motorists will go out of their way to patronize. Don't render your free service grudgingly, but make your customers feel that you are glad to serve them, that you have the free service for their benefit, and that it is a pleasure to render this free service. They will repay you many fold for the effort and expense you incur for this service.

New Supervisor at Laredo

HOUSTON, Sept. 15.—J. F. Fouch has arrived at Laredo from Fort Worth to assume his duties as Laredo district deputy supervisor of the oil and gas division of the Railroad Commission of Texas. He succeeds Leslie McKay, recently promoted to be chief deputy supervisor at Austin, headquarters of the division.

Installation, Maintenance and Care Of Gasoline Pumps

By W. W. Gillette

THREE things to be considered when purchasing a gasoline pump are long life, accuracy and attractiveness. While the latter is important, yet more so are the other two, as without these features the pump would be worthless.

The long life of a gasoline pump is mainly dependent upon two factors—quality and kind of materials used in its manufacture—and care given while in use. The best policy, of course, is to buy pumps of high quality made by a reputable manufacturer. With proper care such equipment will give years of service even under the heavy duties imposed by the busy station.

A gasoline pump like any other piece of mechanical equipment requires lubrication. This is imperative if the original quality of materials used by the manufacturer is to be preserved. The pump should be oiled regularly, using a good grade of lubricant. For most purposes it has been found a safe plan to oil the pump thoroughly after every 2000 gallons or at least every week or 10 days.

At this time all grease cups should be turned down and reservoirs filled with oil. Gears and cog racks should be lubricated with a heavy oil or light grease, using a medium oil on other moving parts. On piston type pumps the cup around the plunger rod should be filled with heavy oil. Registering dials should be oiled occasionally using a light oil similar to 3 in 1. Quantity stop rods should be oiled at various intervals using a medium oil. These parts require more frequent lubrication than others and usually they are readily accessible to permit quick oiling.

PROPER lubrication pays for itself many times. Savings are made in repairs—besides minimizing the danger of breakdowns. In addition, the life of the pump is materially increased which cuts down the annual cost of investment.

Accurate measurement is very important at all times. Inaccuracy is detrimental—whether it be under or over-measurement. Pumps are inspected at irregular intervals by the sealers of weights and measures and it behooves the filling station owner to see that his pumps are measuring correctly.

Short measuring, while perhaps not intentional, may lead to trouble with the authorities and in any case, it usually becomes public knowledge that the filling station has been found guilty of this practice. It will be admitted that this is conducive neither to good will nor to increased business.

On the other hand, over-measurement works to the disadvantage of the filling station. It digs into profits. Gasoline is bought by the gallon and should be sold that way.

It is always a good plan to know just what your pumps are doing. Check them at least once daily, twice or more if you think it necessary, but at no time should the accuracy of the pump be checked by using ordinary gallon or multiple gallon cans. There is a big variance in so-called gallon measures.

When checking in the mornings, do not measure the first pump full, as it is apt to be short if the pump has stood for any length of time. The second or third pump full can be measured and the accuracy of the pump then certified. Use a measure which has been checked and endorsed by the department of weights and measures. By doing this, you will be protecting your interests as well as those of your customers.

Good pumps, both piston type and visible, are provided with adjustable quantity stops. However, in no case should the seals be broken or pump adjusted unless absolutely necessary.

Many times the pump is blamed for troubles which occur in the system but which in no way are attributable to it. Leaky pipe lines and tanks are more often the causes of such troubles. Gasoline is very hard to hold—it will penetrate through small openings through which even water will not flow. A simple test (explained below) for piston type pumps will show whether or not there is a leak in the system. After completion of the discharge stroke, a slight pause should be made before returning the plunger to the bottom of the cylinder.

UPON returning the plunger there should be a slight dribble from the nozzle. If no such dribble appears there is a possibility of a leak in the union connection at base of pump or in the pipe line. In pumps equipped with a discharge sight glass it is very easy to detect leaks, as the gasoline will not show in the glass if there is a leak in the system. All new pumps are tested and sealed by the manufacturer and should measure accurately when received.

Proper installation of tank, pipe lines, etc. is absolutely necessary to insure correct measure and is so important that attention must be called to it. Special care should be used in placing the tank to be certain that it rests solidly to avoid any possible chance of settling or slipping, which would loosen or break the connections.

Tanks must be set level, otherwise the contents cannot be correctly gauged. The tank should never be placed in ground containing cinders, ashes, lime or salt water without treating the tank to resist the chemical action of these substances. The most satisfactory treatment is to cover the tank with two or three coats of tar, dusting the last coat with sand or cement while it is still soft and sticky.

Good quality galvanized pipe of the size recommended by the manufacturer

W. W. GILLETTE

Mr. Gillette was born near Fort Wayne, Ind. He attended public school and later graduated from high school. After graduating he secured a sales and business training. Upon completion of his school work he was employed for some time as a traveling salesman for a mill and factory supply house. In 1909 he became connected with S. F. Bowser & Co. and has been with them ever since. He has been doing service work for over 15 years—both on the road and at the home factory. This has given him a ready understanding of service problems, and "Bill" is always glad to pass his experience on to others.

should be used, care being exercised to see that it is clean on the inside and free from scale. Suction and vent pipes should pitch downward from the pump to the tank at least ¼-inch to the foot with no traps or air pockets. As few elbows or bends should be used as possible, as each 90-degree ell produces as much friction as about 30 feet of pipe.

A SWING joint made of pipe fittings should be installed in the line at the point where the vertical pipe from the tank connects into the horizontal suction line, to compensate for any movement of the tank or pump, which would otherwise result in damage to the pipe or connections. The bottom of the tank should not be over 12 feet from the bottom of the pump—a greater distance will, in most cases, affect the accuracy of the pump.

All vacuum producing pumps have a limit within which they can successfully operate. The height to which a liquid will rise vertically in a pipe line is governed principally by the pressure of the atmosphere. Conservative tests have shown that the maximum height to which gasoline will rise is about 12 feet. Should the distance be greater than this a full charge of gasoline will not be drawn into the pump, resulting in short measurement.

In high altitudes the maximum vertical lift is greatly reduced while under favorable conditions at sea level, the maximum vertical lift may be in excess of 12 feet.

The horizontal distance from pump to tank should be as short as possible, but if absolutely necessary can be increased to 150 feet or more, but follow closely the instructions for laying line as previously explained. In exceptionally long suction lines the efficiency of the pump can be materially increased by increasing the size of the suction pipe one or even two sizes.

Special care should be used in making the connections. Do not use compounds on connections which will not resist the action of gasoline, as this will result in leaks which destroy the efficiency of the pump. All connections should be treated with a compound of litharge and glycerin to insure tightness.

DO NOT underestimate the effect of a trap in the suction line of a piston type measuring pump. Traps have been found to be one of the most annoying causes for under measurement to be encountered.

Pumps should be located in such position and place as to permit easy entrance to and exit from the filling station grounds. The layout of buildings and location of tanks and pumps depends a great deal upon the size and shape of the grounds, location of neighboring buildings, etc. Most manufacturers will be glad to make suggestions or submit plans as to arrangement of the equipment and building when they have been made aware of the facts.

The pumps should be securely fastened to relieve strain from the pipe line and connections. Mounting should be made on a concrete base or island, preferably from 6 to 10 inches above the driveway and extending at least 12 inches from each side of the pump base, in order to protect the pump from being bumped by passing cars. When pumps are mounted on sidewalk a space of at least 12 inches should be allowed between the curb and the pump.

If a new pump should fail to measure accurately, it is practically certain that the trouble is in the suction line, caused by defective fittings, broken pipe or leaky connections. In some cases the trouble may be due to a leaky foot or line valve caused by dirt becoming lodged between the valve poppet and the valve seat.

ALWAYS inspect these first before adjusting the pump. If an installation has been used for some time there is a possibility that the pump needs adjusting. But before doing this, all other parts of the system should be carefully examined. If, after trying every thing else, the pump is still inaccurate, then it can be adjusted.

Attractive appearance is one of the silent salesmen that draws customers to the filling station. Attractiveness of filling station design and equipment is becoming recognized more and more as a necessity. It adds an air of prosperity to the station. Like anything else worth possessing, pumps must be looked after and conditioned occasionally. After a few years the finish of the pump will become dull, due to exposure to the weather.

The finish can be restored by applying two coats of good quality outdoor varnish. Before doing this care should be used to see that the finish is sanded (using very fine sand paper) until the surface is smooth.

Should the paint become nicked or peeled, it should be scraped or removed entirely, depending upon its condition. In either case, the pump should be well sanded to insure smoothness and two coats of enamel then applied. After sufficient time has been allowed for drying, two coats of outdoor varnish should be given it. The time required for drying is usually specified by the paint manufacturer. Make it a point to dust off the outside of the pump daily, using a good furniture or automobile polish, keep the nickeled or brass parts shined.

The glass bowls on visible pumps often become stained due to the presence of moisture or acid in the gasoline. This not only detracts from the appearance of the station but leads customers to believe that they are receiving inferior gasoline. This discoloration can be removed by cleaning the inside of the bowl with a good grade, scratchless scouring powder. Attractive appearance is well worth the slight work required to keep the pump in this condition.

WHEN writing or wiring a manufacturer for service be sure to furnish sufficient information which will enable the service man to supply the necessary parts or tools. Give the serial number, the model number or any other information shown on the name plate. Incidentally, when painting the pump be sure not to paint over the name plate. This is done in many cases and when service is necessary proper information cannot be given. Always be sure to explain in detail the nature of the trouble. This enables you to get quicker service as the service man will arrive prepared to make whatever repairs are necessary.

Follow the directions supplied by the manufacturer—don't be afraid to oil your pump—oil won't hurt it. Protect your equipment and your dollars! Take Care Of Your Pump!

Current for Del Rio Pipeline Planned

HOUSTON, Sept. 15.—Central Power & Light Co., it is reported from west Texas, will build a 46-foot dam on Devils river, about 20 miles northwest of Del Rio, to supply water power for a hydro-electric plant that will furnish current for electrifying pumping stations on the Illinois Pipeline Co.'s line from the Yates field, Pecos county, to Del Rio.

Illinois Pipeline Co. now has 25 miles of its line laid and buried northwest of Del Rio. It is 140 miles in length and the work of completing it is expected to be finished next month. A parallel 10-inch line from Yates field to Del Rio is reported to be under consideration.

Three of the company's 80,000 barrel steel storage tanks have been completed at the Del Rio tank farm and work is going ahead on seven more. The present building program calls for a total of 25 tanks, or steel storage room of 2,000,000 barrels. It is also reported the Illinois, which is a companion corporation to Mid-Kansas Oil & Gas Co. (subsidiary of Ohio Oil Co.) has made a conditional contract for the possible construction of an additional 2,000,000 barrels of steel storage room.

TULSA—A. W. Duston, manager of the land department, Independent Oil & Gas Co., has resigned to enter private geological practice. He will open offices in Tulsa.

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CONFIDENCE

We have written a good many letters during the life of our business and we have grown mighty particular. Perhaps you have found, as we have, that although a letter is an inanimate thing of paper and ink, it can be made by study and subtlety of wording to breathe the personality of the sender and his genuinely human desires—but it is beguiling—unless you are careful it may frown when you want it to smile—and that is just a point of this frank discussion with our customers.

We deal with you very often at long range. We are doing our utmost to please you always. If we could step right out of our office into yours, we could say "Hello Bill" with a sincere ring in our voice and a friendly smile, but convention decrees when we write you to say "Dear Sir"; and that goes for friends and strangers; or when we wire, you are not even saluted.

Please accept our assurance that the Imperial Oil Marketing Company is a human organization and invites you to come to it without reserve.

SPECIFICATIONS

60/62 gravity W.W.D.T. better than U.S. Motor Specifications gasoline
58/60 gravity W.W.D.T. better than U.S. Motor Specifications gasoline
55/57 gravity special Anti-knock cracked gasoline
U. S. Motor specifications — 25 Benzol equivalent
Color guaranteed 21 or better at destination
42/44 gravity W.W.D.T. Kerosene
Flash 130-150 Cleveland open cup
Fire 155-175 — E.P. under 600
38/40 gravity clean light straw furnace distillate
Flash 150-175 Cleveland open cup — Fire 170-195
Sulphur–under 2%
Odor–sweet (acid treated)
28/30 gravity straw gas oil
Flash–225-235 Cleveland open cup — Fire–243-255
Sulphur–under 2%
Cold test–below zero — Odor–sweet
14/18 gravity refinery fuel oil, under 225 visc. Furol
18/20 gravity Smackover crude oil
Road Oils — Petroleum Coke

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ATLAS LIFE BUILDING
TULSA, OKLAHOMA

Magnolia's Price Advance Not Reflective Of General Betterment of Outlook

By Laurence E. Smith
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LITTLE RIVER, proration, curtailment, conferences, all yielded place in public interest the past week to the Magnolia Petroleum Co., which hauled off on Sept. 14 without statements before or after the fact and increased its price on Mid-Continent and north Texas crude to parity with the other principal purchasers. Thereby, it wiped out a 15-cent differential maintained since May 5. The latest advance, beginning at the grade 30-30.9°, agrees with schedules of the Prairie, Carter, Sinclair and other large buyers. Below that point, the Magnolia posts one price, $1.05.

There would be no point in hailing this action as a turn in the situation and nobody was inclined so to do. It so happens that Magnolia needs more light oil than it is getting or was able to get at the lower prices. It took the action appropriate to get what it wants and if it shouldn't succeed, it would not hesitate to raise it some more.

This observation is based upon the outstanding fact that the Magnolia does just as it jolly well pleases at all times. If it is getting too much oil, or if its price for refinery products is running too low with respect to its raw material, it cuts the price of the latter, no matter what other folks think about it. There was illustration of that last spring. Now, in a world full of bear stories, it climbs back up the price scale and perches with the rest of them.

Last April, when the Magnolia was on the bear side of the market, its runs in Oklahoma totaled about 48,000 barrels. This figure increased during May, June and July, averaging during the latter month 59,000 barrels daily. In August, runs in Oklahoma were 57,000 barrels, but the company's refinery requirements were such that it drew on stored oil in Oklahoma to the extent of 3,000 barrels daily. This was the first time it had made withdrawals since February.

On various dates, beginning with June, the Magnolia's production and runs in the Seminole district were as follows:

Date	Production	Runs
June 2	17,000	22,000
June 10	21,000	23,000
June 22	25,000	32,000
June 30	22,000	29.000
July 13	17,000	25,000
July 21	18,000	25,000
July 31	18,000	26,000
Aug. 2	21,000	24,000
Aug. 5	34,000	31,000
Aug. 7	29,000	42,000
Aug. 13	29,000	44,000
Aug. 24	20,000	24,000
Aug. 31	23,000	32,000
Sept. 14	21,000	34,000

Magnolia has pipe line capacity of around 50,000 barrels daily out of the Seminole district; it has stored oil in the field of around one million barrels. Its own properties in the district are developed and except for new discoveries, it can hope for no increase in its own oil. At the time of the price advance it was connected to its own properties and to those of the Atlantic Oil Producing Co. in the Seminole district.

There was a persistent report the past week that the Magnolia had contracted to sell a million barrels of crude to somebody. That would have a bearing on its action, if true. Otherwise, the explanation for the price raise must rest upon the fact of withdrawal from storage and its desire to keep from tapping stocks that were accumulated at higher prices than the present.

Little River continued to claim principal field interest over the week. The Seminole district as a whole ended the week with production just what it was the week before, although 36 producing wells were added. Bowlegs fell 10,000 barrels and gained 10 wells; Little River had two more wells but, due to pinching-in, was held to 13,000 barrels the same as at the end of the previous week; Earlsboro was up 13,000 barrels, with 21 new wells; Seminole proper fell 2,000 barrels and had one less producing well; Searight stood still on production with four new wells.

Little River continues to be a mystery. It promises to be as erratic as was Earlsboro in its most erratic days. The latest well to display temperament is the No. 6 Nitey of the Blackwell Oil & Gas Co., in the SWc NE SE of 35-8-6, the farthest north producing well. It was a big well, making 4,590 barrels on Sept. 11 but on Sept. 16 had fallen to 1,880 barrels. It was flowing wide open.

Wells will start coming in in bunches within the next 30 to 40 days. There are a total of 109 operations in the district, including the completed wells. The ones farthest along are: Blackwell Oil & Gas Co.'s No. 3 Nitey, drilling at 4,015 feet; same company's No. 4 Nitey, cementing 8-inch at 3668 feet; same company's No. 5 Nitey, cementing 8-inch at 3,640 feet; Gypsy Oil Co.'s No. 1 Wilkie, SE NE SW 35-8-6, cementing 8-inch at 3815 feet; Producers & Refiners No. 1 Dungan, SE NW SE 35-8-6, drilling at 3895 feet; Gypsy Oil Co.'s No. 1 Campbell, SW NW SE 36-8-6, cementing 8-inch at 3665 feet; Mid-Continent Petroleum Corp.'s No. 3 Wadsworth, NW SW SW 36-8-6, cementing 8-inch at 3884 feet; Superior Oil Corp.'s No. 1 Wadsworth, NW SE NE 1-7-6 cementing 8-inch at 3770 feet; Tidal Oil Co.'s No. 1 Jackson, SE NE NW 1-7-6, cementing 8-inch at 3800 feet; Barnsdall Oil Co.'s No. 1 Davis, SE NW 2-7-6, cemented and drilling at 3922 feet;

Drilling Operations in Oklahoma, Kansas and Texas, Week ended Sept. 17, 1927

	September 17 — Week Ended —					September 10				
	Loc.	Rigs	Drg.	S.D.	Total	Loc.	Rigs	Drg.	S.D.	Total
OKLAHOMA										
Burbank	..	2	10	9	21	..	5	8	9	22
Other Osage	8	6	12	4	30	4	3	17	5	29
Bristow-Cushing	2	3	34	7	46	1	3	39	7	50
North Oklahoma	8	10	49	48	115	8	8	64	44	124
South Oklahoma	10	16	112	45	183	13	20	115	36	184
Muskogee	..	2	34	14	50	..	8	30	11	49
Okmulgee-Bristow	9	37	59	19	124	7	41	63	19	130
Tonkawa	..	..	5	2	7		No Report			
Seminole Dist.	26	29	510	39	604	26	35	539	42	642
Total Oklahoma	63	105	825	187	1,180	59	123	875	173	1,230
KANSAS	26	56	120	68	270	26	56	120	68	270
TEXAS										
Central	..	109	198	130	437	..	114	183	129	426
East		No Report					No Report			
Panhandle	..	78	99	103	280	..	73	110	101	284
N. Central	..	34	86	33	153	..	37	95	33	165
West	..	102	166	97	365	..	110	175	92	377
Laredo	..	1	25	19	45	..	1	25	19	45
Total Texas	..	324	574	382	1,280	..	335	588	374	1,297
GRAND TOTAL	89	485	1,519	637	2,730	85	514	1,583	615	2,797

Seminole District Production by Companies and Leases, September 16 and September 9, 1927

Company	Farm	S.T.R.	Sept. 16th No. Wells	Sept. 16th Prod.	Sept. 9th. No. Wells	Sept. 9th. Prod.
BOWLEGS						
Amerada	Rascoe	15- 8-6	8	6,905	8	6,770
Atlantic	Baker	1- 8-6	4	2,034	4	2,483
Atlantic	Fleet	23- 8-6	4	1,689	4	1,919
Atlantic	Grayson	12- 8-6	1	2,289	1	2,385
Atlantic	A. Jones	16- 8-6	3	220	4	115
Atlantic	C. Jones	9- 8-6	4	1,823	1	2,520
Total Atlantic			16	8,055	14	9,422
Barnsdall	McNac	28- 8-6	1	55	1	50
Barnsdall	Murrow	11- 8-6	4	2,116	4	2,272
Total Barnsdall			5	2,171	5	2,322
Carter	Bowlegs	15- 8-6	3	2,625	3	2,987
Carter	Harjoche	15- 8-6	6	2,295	6	2,585
Carter	Hilly	23- 9-6	1	1,615	1	1,690
Carter	McGeisey	15- 8-6	1	0	1	0
Carter	Walker	15- 8-6	2	1,035	2	1,040
Carter	Wise	23- 8-6	10	9,090	10	9,845
Total Carter			23	16,660	23	18,147
Empire	Lacey	15- 8-6	6	1,547	6	1,722
Empire	Wise	23- 8-6	2	2,119	1	2,235
Total Empire			8	3,666	7	3,957
Gypsy	Bowlegs	22- 8-6	1	645	1	737
Gypsy	Brown	33- 8-6	1	102	1	90
Gypsy	Cumsey	8- 8-6	3	855	3	775
Gypsy	Grayson	13- 8-6	1	1,512	1	1,812
Gypsy	Walker	15- 8-6	8	3,852	8	3,765
Gypsy	Wise	23- 8-6	2	167	2	185
Total Gypsy			16	7,133	16	7,364
Independent et al	Coker	21- 8-6	1	60	1	485
I. T. I. O.	Barnett	24- 8-6	2	1,296	2	1,415
I. T. I. O.	Billington	22- 8-6	3	1,216	2	947
I. T. I. O.	Bowlegs	22- 8-6	8	3,303	7	3,843
I. T. I. O.	Davis	13- 8-6	3	1,861	3	1,980
I. T. I. O.	Fay	18- 8-6	2	1,555	1	1,592
I. T. I. O.	Goforth	15- 8-6	10	3,049	10	3,965
I. T. I. O.	Livingston	15- 8-6	11	10,268	12	10,680
I. T. I. O.	Lizzie	11- 8-6	1	500	1	499
I. T. I. O.	Walker	15- 8-6	8	3,058	8	3,711
I. T. I. O.	Wilmont	15- 8-6	4	2,658	4	3,056
I. T. I. O.	Work	24- 8-6	1	597	1	914
I. T. I. O.	Youngblood	24- 8-6	4	823	4	947
Total I. T. I. O.			57	30,184	55	33,499
McCullouch	Bowlers	22- 8-6	3	300	3	560
Mid-Continent	Baker	10- 8-6	4	4,744	4	4,817
Mid-Continent	Bowlegs	22- 8-6	1	1,010	1	1,040
Mid-Continent	Hutke	24- 8-6	1	2	1	5
Total Mid-Continent			6	5,756	6	5,862
Minnehoma	Bowlegs	15- 8-6	4	2,033	4	2,455
Prairie	Gahagan	23- 8-6	3	2,130	3	2,425
Prairie	Harber	10- 8-6	7	4,485	7	4,460
Prairie	Templeton	12- 8-6	1	3,185	1	3,040
Prairie	Whitney	23- 8-6	4	440	4	888
Total Prairie			15	10,240	15	10,813
Pure	Reed	14- 8-6	16	11,060	14	10,847
Pure	Strother-E	16- 8-6	1	10	1	15
Pure	Strother-D	14- 8-6	2	1,213	1	1,231
Pure	Strother-F	10- 8-6	1	631	1	652
Total Pure			20	12,904	17	12,745
Roxana et al	Taylor	16- 8-6	6	2,427	5	3,213
Shaffer	Lacey	14- 8-6	3	813	3	1,032
Sinclair	Adam	22- 8-6	1	0	1	0
Sinclair	Bowlegs	22- 8-6	1	20	1	0
Sinclair	Cumsey	10- 8-6	1	936	2	876
Sinclair	Ellen	11- 8-6	3	1,665	3	1,680
Sinclair	Harjo	14- 8-6	3	2,535	3	2,475
Sinclair	Jones	8- 8-6	4	7,875	4	7,570
Sinclair	Taylor	10- 8-6	4	4,073	3	4,075
Sinclair	Walker	22- 8-6	4	2,510	4	2,790
Total Sinclair			21	19,614	21	19,466
Texas	Reed	14- 8-6	7	6,850	7	7,425
Tidal	Harjoche	10- 8-6	3	2,465	4	2,515
Twin State	Jones	11- 8-6	1	2,120	1	2,185
TOTAL BOWLEGS			225	140,368	215	150,247
LITTLE RIVER						
Amerada	Nitey	2- 7-6	1	100	1	405
Blackwell	Nitey	35- 8-6	3	3,895	3	2,357
I. T. I. O.	Dungan	35- 8-6	1	984	1	942
I. T. I. O.	House W. E.	1- 7-6	1	1,185	1	1,200
I. T. I. O.	House M. A.	1- 7-6	1	1,209	1	1,188
I. T. I. O.	Jackson	1- 7-6	1	1,189	1	2,954
I. T. I. O.	Nitey	2- 7-6	2	2,362	1	1,253
I. T. I. O.	Reed	1- 7-6	1	1,162	1	2,459
Total I. T. I. O.			7	8,091	6	9,995
Mid-Continent	Wadsworth	36- 8-6	2	1,360	1	475
TOTAL LITTLE RIVER			13	13,446	11	13,233

Company	Farm	S.T.R.	Sept. 16th No. Wells	Sept. 16th Prod.	Sept. 9th. No. Wells	Sept. 9th. Prod.
EARLSBORO						
Amerada	Anderson	15- 8-5	4	3,415	4	3,630
Amerada	Cowden	4- 9-5	4	1,780	4	2,345
Amerada	Rodgers	3- 9-5	2	6,490	2	7,500
Total Amerada			10	11,685	10	13,475
Barnsdall	Bruner	10- 9-5	1	0	1	28
Barnsdall	Brown	10- 9-5	2	4,029	1	4,464
Barnsdall	C. Cudjo	11- 9-5	1	28	1	31
Barnsdall	D. Davis	11- 9-5	2	2,154	2	2,948
Barnsdall	J. Davis	11- 9-5	2	232	2	250
Barnsdall	M. Davis	11- 9-5	3	2,154	3	2,150
Barnsdall	Gibson	9- 9-5	6	7,030	6	8,238
Barnsdall	Hearn	15- 9-5	1	18	1	0
Barnsdall	Hooly	4- 9-5	1	0	1	0
Barnsdall	Ingram	4- 9-5	1	863	1	272
Barnsdall	Pack	10- 9-5	4	1,443	4	2,503
Barnsdall	Peter	10- 9-5	4	798	3	728
Barnsdall	Sebolka	15- 9-5	1	2,960	1	2,813
Barnsdall	Sango	2- 9-5	1	135	1	154
Barnsdall	Smith	15- 9-5	1	9	1	2
Barnsdall	Sullivan	1- 9-5	4	2,063	4	2,037
Barnsdall	Watsutke	12- 9-5	2	2,115	2	2,075
Total Barnsdall			37	26,031	35	28,693
Carter	Payne	12- 9-5	2	1,670	2	1,775
Carter	Sango	2- 9-5	2	560	1	180
Total Carter			4	2,230	3	1,955
Continental	Spencer	12- 9-5	2	5,300	2	5,715
Crosbie	Bryant	9- 9-5	2	2,532	2	1,643
Empire	Edmundson	3- 9-5	2	2,453	1	3,136
Gypsy	Bruner	10- 9-5	3	7,140	2	5,585
Gypsy	Carter	11- 9-5	4	3,665	4	4,017
Gypsy	Earl	16- 9-5	1	0	1	0
Gypsy	McFarland	9- 9-5	2	17	2	0
Gypsy	Noble	12- 9-5	1	1,505	1	1,845
Gypsy	Peter	10- 9-5	4	1,725	4	1,765
Gypsy	State	16- 9-5	4	717	4	995
Gypsy	Strain	17- 9-5	1	0	1	10
Total Gypsy			20	14,769	19	14,232
Independent	Bruner	10- 9-5	3	408	1	38
Independent	Gaines	11- 9-5	2	10,130	1	2,060
Independent	Knappen	8- 9-5	3	1,665	3	680
Independent	O'Dell	4- 9-5	4	4,480	4	6,410
Independent	Sullivan	10- 9-5	4	6,560	3	2,720
Total Independent			16	23,243	12	9,848
Interocean	Payne	12- 9-5	1	80	1	188
Magnolia	Bryant	9- 9-5	4	1,138	4	1,890
Magnolia	Cowden	4- 9-5	2	472	0	0
Magnolia	Edmundson	3- 9-5	2	1,330	2	2,093
Magnolia	Holmsley	11- 9-5	5	8,243	6	9,061
Magnolia	Ingram	10- 9-5	1	43	1	37
Magnolia	Lena	10- 9-5	3	65	2	184
Magnolia	Seay	12- 9-5	4	2,361	4	2,484
Magnolia	Simpson	10- 9-5	4	79	2	0
Magnolia	Sparks	11- 9-5	6	5,201	6	5,244
Total Magnolia			31	18,932	28	20,993
Mid-Continent	McCumber	9- 9-5	6	3,195	5	2,635
Mid-Kansas	Anderson	14- 9-5	1	0	1	0
Phillips	Dunnaway	15- 9-5	1	32	1	30
Phillips	Graham	9- 9-5	6	1,497	6	1,630
Total Phillips			7	1,529	7	1,660
Prairie	Baker	24- 9-5	1	50	1	50
Prairie	Davis	13- 9-5	3	2,425	3	1,425
Prairie	C. Graham	3- 9-5	2	5,600	2	5,960
Prairie	O. Graham	10- 9-5	4	8,205	4	8,945
Prairie	Stidham	11- 9-5	9	16,005	7	9,505
Total Prairie			19	32,285	17	25,885
Roxana	Hearn	13- 9-5	1	45	1	0
Roxana	Spencer	12- 9-5	2	4,280	2	3,930
Total Roxana			3	4,325	3	3,930
Sinclair	Foreman		1	0	1	0
Sinclair	Hollins		3	3,410	1	2,300
Total Sinclair			4	3,410	2	2,300
Skelly	Spencer	12- 9-5	2	4,479	1	2,807
Skelly	Anderson	2- 9-5	1	165	0	0
Texas	Brown	10- 9-5	3	35	3	181
Texas	Rodgers	5- 9-5	1	7,050	1	7,165
Texas	Wilmont	10- 9-5	1	247	1	206
Total Texas			5	7,332	5	7,572
Tidal	Watkins	9- 9-5	4	1,540	4	2,775
Twin State	Barker	12- 9-5	1	2,150	1	2,895
Twin State	Hearn	2-9 -5	1	2,315	1	2,580
Total Twin State			2	4,465	2	5,475
TOTAL EARLSBORO			187	169,860	166	156,957
TOTAL SEARIGHT			55	31,140	51	31,490
TOTAL SEMINOLE PROPER			319	73,106	320	75,339
GRAND TOTAL SEMINOLE DISTRICT			799	427,920	763	427,266
Average Per Well				000.00		

Twin State Oil Co.'s No. 1 Hyde, SE NE SW 2-7-6, cemented 8-inch at 3910 feet; Twin State's No. 2 Hyde, NE SW of 2-7-6, cemented 8-inch at 3862 feet.

Off southwest of the discovery well of the Little River field by about five miles is an interesting situation. Barnsdall Oil Co.'s No. 1 Hotulka, in the SE NW SE of 22-7-6 has been shut down on top of the Viola lime since May. It had a good showing of oil and was looked upon as the discovery well of another pool. The company was not hurried by lease obligations, hence held it back. The Independent Oil & Gas Co. is now drilling in the SW NW NW of 23-7-6, at

Completions in Oklahoma and Kansas, Week Ended September 17, 1927

OKLAHOMA

Caddo County

Company	Well No.	Location	Depth	Init. Prod.
Magnolia	1	SEc NW 1-5-10 W	2087-2097	20

Creek County

Company	Well No.	Location	Depth	Init. Prod.
Pure	6	NWc SE NE 30-14-8	3532-3541	80
Cumberland	6	SWc SE NE SE 13-17-10	2361-2372	2M
Kennedy et al	1	SWc SE SE	2419-2439	180
Transcont	2	NEc SE SW 14-17-8	T.D. 3245 OWD	Dry
Tibbens	1	NWc SE SE 21-15-8	3296	Dry
Barnsdall	1	NEc NW NW 20-18-9	T.D. 3320	Dry
Haddock et al	1	NWc NE SE 8-17-9	T.D. 3320	Dry
Ted Ray	2	CSL SE SW 13-17-10	T.D. 2124 OWD	Dry
Pioneer	1	CNL SW NE 21-17-10	T.D. 2996	Dry
Wolfe	1	SWc SE NE 6-16-9	T.D. 3120	Dry
Tibbens	37	CWL E½ SE NW 30-15-9	T.D. 3704	Dry

Garfield County

Company	Well No.	Location	Depth	Init. Prod.
Sinclair	75	NEc SW NE 13-22-4 W	T.D. 845	3M
Knox	4	CSL SW NE 26-22-4 W	1750-1760	85

Garvin County

Company	Well No.	Location	Depth	Init. Prod.
Day	1	CSL N½ NE 22-1-1-E	T.D. 3040	Dry

Grady County

Company	Well No.	Location	Depth	Init. Prod.
Noble et al	1	NWc 24-5-8-W	T.D. 2227	Dry
Magnolia	6	SWc NW SE 23-5-8 W	T.D. 2300	29M
Carter	1	SEc 6-3-5 W	1965-1983	200
Carter	4	NEc NE SE 21-3-5 W	1692-1713	550
Carter	1	SWc NW 22-3-5 W	1701-1707	80

Kay County

Company	Well No.	Location	Depth	Init. Prod.
Harris-Hahn	1	SEc NE 17-29-1 E	749-752	1M
Hazel et al	2	SEc SW 21-27-1 E	2525	Dry
Blackwell	1	C SE SE 6-26-1 E	T.D. 440	Dry

Kingfisher County

Company	Well No.	Location	Depth	Init. Prod.
Bu-Vi-Bar	1	SWc SE SW 16-19-5 W	T.D. 6210	Dry

Lincoln County

Company	Well No.	Location	Depth	Init. Prod.
Magnolia	2	NEc SW NW 7-15-4	3388-3392	75

Logan County

Company	Well No.	Location	Depth	Init. Prod.
Roxana	1	SWc NE SE 30-19-4	5917-5985	2880

Muskogee County

Company	Well No.	Location	Depth	Init. Prod.
Wilson et al	6	C SE SE 34-16-15	1062-1095	1M
Link	2	NWc NE SE 32-15-15	T.D. 2565	Dry

Okfuskee County

Company	Well No.	Location	Depth	Init. Prod.
Kissler	1	SEc NW SE 18-12-11	T.D. 3640	Dry
Mid-Cont	1	SWc SE 13-12-6	T.D. 4708	Dry
Riverland	2	SEc SW SW 19-11-11	3643-3652 OWD	1720

Okmulgee County

Company	Well No.	Location	Depth	Init. Prod.
Sheldon et al	1	C SW SE 15-13-12	2872-2882 OWD	91
Eagle Picher	4	CWL NE SE 34-12-12	1865-1953	2M
Misner	2	CWL SW NE 10-15-14	986-992	20

Osage County

Company	Well No.	Location	Depth	Init. Prod.
Winona	1	NWc 17-29-11	1081-1110	8
Phillips	1	SWc NW SE 17-27-6	2905-2968	75
Knupp	12	CSL SE 35-27-11	972-1049	10
Pawhuska	43	SEc SW 34-26-9	1694-1766	3½M
I. T. I. O.	371	SWc SE SE 20-23-8	1250-1255	1¾M
Superior	3	CSL N½ NW 20-23-10	T.D. 2340	Dry

Pawnee County

Company	Well No.	Location	Depth	Init. Prod.
Superior	1	SEc NW NE 20-21-7 E	2515-2524	2M

Pontotoc County

Company	Well No.	Location	Depth	Init. Prod.
Homaokla	1	SEc NE SE 16-5-8 E	2477-2487	237
Ramsey	1	SEc NW SW 17-5-8	2331-2333	50M
Ramsey	1	NEc SW 20-5-8	2446-2512	710
American	1	SWc SE 28-5-6 E	T.D. 3300	Dry

Pottawatomie County

Company	Well No.	Location	Depth	Init. Prod.
Magnolia	1	NWc NE 30-7-4	T.D. 4273	Dry
Barnsdall	1	SEc NW SE 4-9-5 E	T.D. 4306	Dry
Philmack et al	2	NEc SE 8-9-5	T.D. 4411	Dry
Gypsy	3	SEc NW 16-9-5	T.D. 4377 OWD	Dry
Magnolia	1	SEc NE SW 4-9-5 E	T.D. 4463	24
Magnolia	3	NEc SE NW 9-9-5 E	4294-4352	274
Magnolia	1	NEc SW 11-7-4	3838-3870	210
Shaffer	2	NWc SW 19-7-4	3794-3924	65
Shaffer	1	NEc SE 24-7-3	3880-3993	30

Seminole County

Company	Well No.	Location	Depth	Init. Prod.
Pure	4	NWc NE SW 3-9-6	4457-4485	105
Barnsdall	1	SEc SW SW 14-9-6	4540-4616 OWD	150
Carter	3	NEc SW SE 34-9-6	4194-4250	60
Carter	2	NEc SE SW 34-9-6	4252-4280	40
Carter	3	SEc NE SE 34-9-6	4070-4095	55
Carter	3	NWc SW SW 35-9-6	4307-4350	10
Magnolia	1	NWc NE NW 2-8-6	4150-4214	157
Sinclair	1	SWc NE 10-8-6	4160-4187	840
Barnsdall	2	NWc SW SW 11-8-6	4200-4235	690
Sinclair	2	SEc NW SW 11-8-6	4140-4182	800
Carter	4	SEc SW 15-8-6	4223-4323	1435
Blackwell	1	SEc 35-8-6	4229-4232	4664
Blackwell	2	SWc SE SE 35-8-6	4177-4195	3792
I. T. I. O.	1	SEc SW SE 35-8-6	4220-4221	4266
Dixie	4	SWc NE NW 32-8-8	4175-4187	50
Shaffer	10	NEc SE SW NW 32-8-8	4195-4205	237
I. T. I. O.	1	SWc NW NW 1-7-6	4148-4151	4837
Amerada	1	SWc SE SE 3-9-5	4237-4265	4665
Amerada	2	SEc 3-9-5	4256-4280	4700
Magnolia	3	SEc SW SW 3-9-5	4250-4261	3136
Barnsdall	1	NEc SE SE 10-9-5	4337-4349	1920
Gypsy	1	NWc NE 10-9-5	4255-4278	4080
Gypsy	4	NEc SW SW 10-9-5	4412-4415	1095
Independent	2	NWc SE NE 10-9-5	4338-4340	2892
Independent	4	SEc NE 10-9-5	3570-3597 OWD	40
Sinclair	1	SWc NE NW 12-9-5	4210-4238	2905
Prairie	3	NEc NW NW 10-9-5	4260-4267	9600
Prairie	3	NWc SE NE 23-8-6	4336-4357	1170
I. T. I. O.	1	SWc NW NW 1-7-6	4147-4149	7026
Gypsy	1	SWc 10-9-5	T.D. 4435	Dry
Magnolia	5	SEc NW SE 10-9-5	T.D. 1590	Dry
Barnsdall	1	SWc SE NW 15-9-5	T.D. 1745	Dry
Barnsdall	2	NWc SE NW 15-9-5	T.D. 4375	Dry
Gypsy	6	SEc NW SE 34-9-6	T.D. 4436	Dry
Slick	6	SEc NW NE 35-9-6	T.D. 4100	Dry
Gypsy	1	SWc SE SE 21-9-7	T.D. 3384	Dry
Gypsy	1	SEc SW SE 21-9-7	T.D. 3614 OWD	Dry
Texas	8	SWc NW NE 14-8-6	T.D. 4444	Dry
Empire	1	NWc SE NW 23-8-6	T.D. 4483	Dry
Wentz	1	SWc NW NE 21-8-7	T.D. 4382	Dry

Stephens County

Company	Well No.	Location	Depth	Init. Prod.
Magnolia	4	SWc NE NE 24-1-9 W	T.D. 2170	Dry

Tulsa County

Company	Well No.	Location	Depth	Init. Prod.
Butler	1	NWc SE SE 32-17-14	1410-1420	1M

KANSAS

Cowley County

Company	Well No.	Location	Depth	Init. Prod.
Texas	2	SEc NW SE 21-31-4 E	2387-2417	140
Roth-Faurot	1	Lot 4 Blk 28	2345-2359	75
Roth-Faurot	1	Blk 14	T.D. 2364 OWD	15
Pyle et al	1	SEc NW 15-35-4 E	T.D. 1870	Dry

Greenwood County

Company	Well No.	Location	Depth	Init. Prod.
Davis et al	1	SWc NW NW 12-22-12	T.D. 2275	Dry
Bisagno et al	1	SEc NE 9-25-13 E	T.D. 1620	Dry
Roxana	2	SWc SE 14-22-11	1852-1896	50
Darby et al	2	NEc SE SW 25-22-12	1625-1288	50
Empire	2	NEc NW NE 25-22-12	1666-1734	600

Lyon County

Company	Well No.	Location	Depth	Init. Prod.
Transcontinental	10	SWc NW NW 31-21-10	T.D. 2304	Dry

Reno County

Company	Well No.	Location	Depth	Init. Prod.
Marland	1	SEc NW 4-26-4 W	T.D. 4348	Dry

Sedgwick County

Company	Well No.	Location	Depth	Init. Prod.
Marland	1	SWc NW SW 5-28-1 W	T.D. 3910	Dry

Sumner County—Oxford

Company	Well No.	Location	Depth	Init. Prod.
Moore et al	1	L. 7-Blk 72	2145-2213	Dry
Homa-Wood	1	SEc NE 15-34-1 E	T.D. 4185	Dry
Noble et al	1	Lot 7-Blk 33	2104-2153	300
Ramsey et al	1	Lot 7 Blk 87	2018-3117	400
Roxana Pet	1	Blk 87	2020-2116	300
Roxana	1	Blk 88	2012-2112	200
Roxana	1	Tract 3 14-32-2	1992-2089	200
Roxana	1	Midland 14-32-2	2005-2103	400
I. T. I. O.	2	SEc SW NE 17-32-2	3693-3711	12

around 2,000 feet. This is about three-fourths of a mile from the Barnsdall well. An executive of the latter company said they had no intention of drilling in their well unless compelled to by other operations. Presumably, the Independent's test is far enough off so that it will not affect the policy of the Barnsdall, but if the Independent should get a well it would require offsetting by others.

Another of the many wildcats in the general Seminole district that were important in their bearing on the territory has fallen by the wayside. Amerada Petroleum Corp.'s No. 1 Lawson, SE NW 2-7-5, three miles southeast of the town of Maud, has a hole full of water at 4758 feet and will be plugged.

In Logan county, where a number of tests were started after the Roxana Petroleum Corp. drilled into the big pay on June 29 its No. 1 McCully, another "discovery" of oil turned attention to the region. The Healdton Oil & Gas Co., in the NW SE of 16-18-4W, completed a gas well in May estimated at 16,250,000 feet with rock pressure of 1,400 pounds. The well was shut in. Last week it was opened to blow off and sprayed about 30 barrels of oil. The Roxana's well is in the SW NE SE of 30-19-4W. They are about five miles apart, the Roxana's well being the northern one. There is no similarity of producing formation, as the Blackwell's pay was in a sand at 3993-4004 feet while the Roxana's well had the Wilcox sand at 5917 feet and has total depth of 5985 feet. The latter well has produced around 200,000 barrels in its life and is holding right around 2,500 barrels daily.

One of the unusual occurrences during the week was the completion by the Pure Oil Co. of a well in the Searight pool, north of the Seminole pool, that found pay around 300 feet deeper than the average for that field. This well was the No. 5 Aldridge, in the SE NW of 3-9-6. It found nothing in the usual productive horizon for this field, but at 4706-10 feet it made 1200 barrels with no water.

Earlsboro's chief contribution in the way of big production was a workover well. This was the Independent Oil

Completions in N.E. Central, West, Panhandle and North Texas, Week Ended September 17, 1927

Company	Well Farm	Location Survey	Depth	Init. Prod.
NORTH AND EAST CENTRAL TEXAS				
Brown County				
Texas	22-Hickman	Benson	1152-1166	24
Danciger et al	6-Haynes	Delgado	1195-1207	5
Cranfill et al	4-Smith	SA&MG	1314-1333	460
Cranfill et al	5-Smith	SA&MG	1335-1350	125
Phillips	1-Newsome	Davis	1332-1340	350
Roxana	7-Smith	SA&MG	1306-1330	200
Roxana	9-Smith	SA&MG	1347-1353	60
Roxana	11-Smith	SA&MG	1321-1345	231
Roxana	12-Smith	SA&MG	1311-1337	500
Sinclair	2-Smith	SA&MG	1218-1231	905
Smith	1-Smith	SA&MG	1322-1338	375
Humble	2-Byler	T&NO	1315-1340	50
La Vantura	1-Smith	Tom	1547-1587	15
Lightfoot	1-Cleveland	Droger	1646-1673	3
Williams	1-Eddington	Mitchell	T.D. 1198	Dry
Forrest	2-Davis	SA&MG	T.D. 1290	Dry
Smith	6-Smith	SA&MG	T.D. 1370	Dry
Texas	1-Davis	SA&MG	T.D. 1350	Dry
Callahan County				
Purchell et al	1-Gray	D&DA	T.D. 505	Dry
Coleman County				
Roth et al	1-Lewis	Coleman	1063-1067	50
Eastland County				
Lewis	3-Hargus	ET	1434-1443	2M
Belva	2-Goode	Stublefield	3681-3688	200
Texas-Pacific	1-Swift	Seyers	2910-3003	10
McCamey et al	1-Morrison	H&TC	T.D. 1546	Dry
Henderson County				
Cayton et al	1-Hoffer	Jeffreys	T.D. 3205	Dry
Limestone County				
Green et al	1-Deal	Garrison	T.D. 3754	Dry
Navarro County				
Magnolia	1-Hodges	Eatch	T.D. 2025	Dry
NORTH TEXAS				
Archer County				
Mear et al	16-Wilson	DLC	1536-1536	125
Brown et al	1-Wallace	DCSL	T.D. 1205	Dry
Barkley et al	1-Andrews	Spavin	T.D. 1150	Dry
McAllester et al	1-Garvey	TEL	T.D. 900	Dry
Roberts	1-Garvey	TEL	T.D. 900	Dry
Baylor County				
Fuller et al	1-Cramo	DW	T.D. 1176	Dry
Cooke County				
Bell	1-Lynch	Scott	1399-1708	65
Dalton et al	1-Fee	Scott	1581-1618	50 7½M
Lynch et al	3-Koelzer	Scott	1627-1667	15
Strube et al	4-Koelzer	Scott	1618-1645	50
Sun	4-Hacker	Scott	1584-1601	50
Gainesville	2-Stoffel	MT	1669-1680	47
Lesh et al	1-Shumaker	MT	1680-1691	94
Oil Operators Trust	1-Stoffel	MT	1589-1616	125
Montague County				
Texas	1-Hinton	Coates	239-240	3M
Wichita County				
Atlantic	1-Waggoner	H&TC	T.D. 1825	Dry
Empire	4-Kempher	WVFH	T.D. 875	Dry
Wilbarger County				
Consolidated	9-Waggoner	H&TC	T.D. 1355	Dry
Young County				
Panhandle	1-Routon	TE&L	T.D. 908	Dry
Moran	7-Stewart	Dawson	798-800	10
Stafford et al	1-Langston	TE&L	591-605	5
PANHANDLE				
Carson County				
Marland	1-Burnett	I&GN	3140-3727	8M
Gray County				
Schaffer	1-Cole	I&GN	T.D. 3315	Dry
Roxana	1-Worley	I&GN	3053-3130	25
Empire	1-Saunders	I&GN	3098-3113	170
Wilcox	3-Coombs	I&GN	2970-2975	5
Hutchinson County				
McMillian	1-Sanford Pool	H&TC	3008-3051	132
Heywood et al	4-Smith	H&TC	2890-300	215
Moore County				
Amarillo	2-Thompson	H&TC	T.D. 3556	90M
Wheeler County				
J & B Oil	1-Farris	H&TC	1935-2035	20M
WEST TEXAS				
Crane County				
Eastland	6-Univ.	Univ.	2853-2950	700
Magnolia	8-O'Keefe	Univ.	2935-3032	1750
Gulf Prod.	19-McElroy	CCSD	2780-2927	140
Garza County				
Pandem	1-Justice	H&GN	T.D. 2765	Dry
Pecos County				
Texon	2-Yates	I&GN	1240-1754	8
Upton County				
Humble	6-Ricker	Denton	2313-2316	1085
Marland et al	1-Smith	Univ.	T.D. 3725	Dry
Winkler County				
Southern Crude	28-Hendricks	PSL	2907-2912	5300
Texon	1-Hendricks	PSL	2812-2814	5M

Completions in North Louisana and Arkansas, Week Ended Sept. 15

Company	Well	Location	Depth	Yield
Louisiana—Bossier Parish—Cartersville				
Woodley & Collins	Farrington No. 1	22-23-12	3087	34M gas
Caddo Parish—Caddo District				
Texas Company	J. F. Herndon No. 8	14-21-15	3650	1000 bbls. 10M gas
Sabine Parish—Pleasant Hill				
Moffett et al	Moore No. 2	5-9-12	3254	1700 bbls.
Ouchita Parish—Monroe				
Ouachita Gas Co.	Lieber No. 4	3-19-4E	2148	12M gas
Richland Parish				
Louisiana Pet. Co.	Binion-Sartor No. 1	22-17-6E	2476	5M gas
Urania—La Salle Parish				
Nat. Gas & Fuel Corp.	Urania M-11	20-10-2E	1550	50 bbls.
Caddo Parish—Waskom				
Owl Oil Co.	Bryson No. 3	7-17-16	985	2M gas
East Texas—Panola County				
Magnolia Pet. Co.	John Lewis No. 6	Co-Ord F-14	1998	50 bbls.
Arkansas—Nevada County				
O'Brien et al	Moss No. B-4	1-14-21	1157	150 bbls.
Stephens—Columbia County				
Autrey Oil Co.	Martin A-3	6-14-20	1176	125 bbls.
Arkansas Invincible Oil Corp.	Culp No. 1	22-15-19	2185	25 bbls.

& Gas Co. and Margay Oil Co.'s No. 1 Gaines, in the SE NE NE of 11-9-5. It had gone dead and while being cleaned out started to flow, increasing until on Friday it made 10,000 barrels in 24 hours. Its previous high production had been 3,200 barrels.

Kansas held little of outstanding importance during the week. The little pool in Rice county, north of Hutchinson, got a little attention when the Independent Oil & Gas Co. cleaned out its No. 2 Miller, NW NE NE 3-21S-6W and was rewarded by a 45-barrel an hour flow. The well was completed in May for initial production of 1165 barrels at 3364-86 feet.

In Greenwood county, Bradley and Skelly Oil Co. have proved a few more locations with their No. 1 Pixlee, southeast corner of 3-22S-10E. Top of pay was found at 2078 feet, first oil at 2102 feet and total depth is 2156 feet. It was still in the sand at that depth and was to be shot with 240 quarts. It is estimated as being good for 500 to 1,000 barrels.

Marland Oil Co. is running three core drills on the big block of acreage it assembled in 23S-6&7W, Reno county, Kansas. This is near the town of Pretty Prairie.

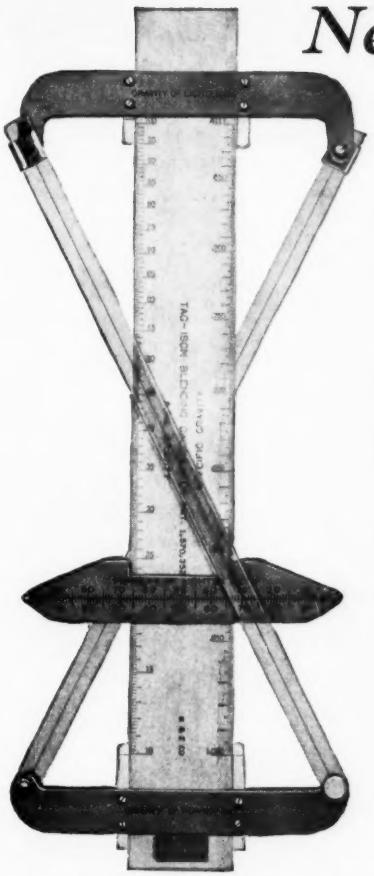
Oldham County, Texas, Has First Show of Oil

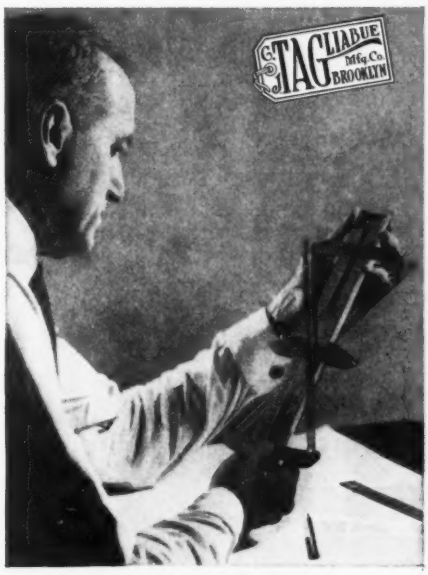
HOUSTON, Sept. 18.—West Texas from the Panhandle to the Trans-Pecos region figured in the week's news with significant developments. A first show of oil in a test drilling about 50 miles west of Amarillo in Oldham county was found by Prairie Oil and Gas Co. at 4490 feet. Casing is being run in the test, which is on the Landergrin Ranch in Sec. 46 League 310, after oil had filled bottom of the hole. In Hutchinson County, Sect. 3, Block B, 3 Roxana Petroleum Corp.'s No. 1, Cockrell, was deepened 2 feet to 2,863 feet, and its flow increased from 2,000 to 8,000 barrels daily.

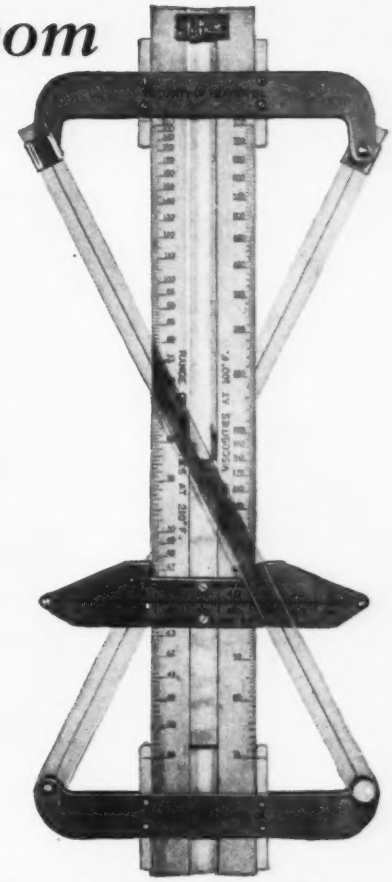
Gulf Production Co.'s Thompson well, reported last week as extending Yates field production across from Pecos into Crockett County in Sec. 71, had increased its flow to 750 barrels an hour at 987 feet. The well was closed in for pipeline connections, but, when opened again Friday, tested 600 barrels the first hour and 530 barrels the second hour. It was then pinched to 30 barrels an hour, which is the outlet allotted to it by the Humble Pipeline, which is handling the oil.

The discovery well of the Scarborough Ranch in northern Winkler county, which was drilled deeper after getting oil shows at 2,990 and 3,124 feet made a 140-barrel head after plugging back from 3,447 to 3,347 feet. Although rated a discovery, Scarborough results are the nearest to commercial production found so far.

New! The TAG-Isom
BLENDING CALCULATOR







On this side of the calculator are the gravity scales, both A. P. I. and Specific Gravity, the latter a great convenience when blends of foreign products are in question.

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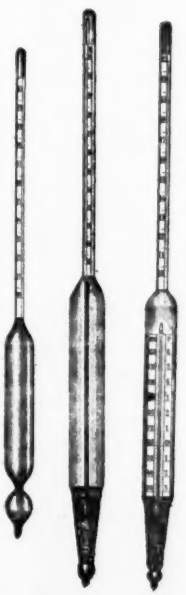

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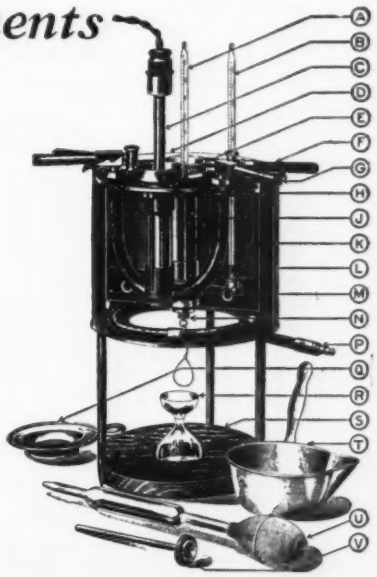

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Officers and Directors of 1927 International Petroleum Exposition

Key to identity of these men is published on opposite page

Exposition Space is Fully Occupied; All's Ready for Opening Sept. 24

Staff Special

TULSA, Sept. 17

FOR more than a week the freight cars have rolled over the tracks that enter the grounds of the International Petroleum Exposition and their contents have been unloaded and moved into position in the open air spaces and indoor booths. The heavy gas engine part of the show came in early and the rig builders had, at the week end, nearly completed erection of the seven derricks which, grouped in the middle of the grounds, suggest some town-lot drilling campaign. Everything will be in place by the opening date, Sept. 24.

"Ten million dollar" is the designation that has been applied by the exposition management to this year's show, meaning by that the value of equipment that will be displayed. No accurate appraisal is possible, of course, in advance of the actual placing of the equipment, but hasty calculation on the basis of former shows indicates that the figure is reasonable.

The attention of industrial leaders has been caught and a number of internationally known men will come. Among them are Charles M. Schwab, head of Bethlehem Steel, who is also chairman of the board of the Chicago Pneumatic Tool Co., one of the big exhibitors; Harvey S. Firestone, head of the tire company that bears his name; former Senator Frank Hitchcock; official representatives of Burma, Mexico, Japan, Peru, Czecho-Slovakia, Canada and England; a delegation of foreign trade representatives of the Ford Motor Co. Besides, there will be present a long list of prominent oil men and officials of equipment manufacturing and supply companies.

THREE outstanding phases of this year's exposition are calculated to enlist the interest of all who are in any wise interested in oil and gas and one of these phases has a large appeal to everyone. There is (1) the exhibits of equipment, for which the show is primarily held, (2) the large scientific and technical display, and (3) aviation.

Of the equipment display, the fact that there are 250 exhibitors and at least 100 more represented through dealers who bought the space is evidence enough that the hundreds of oil men that attend, will see something of about all that goes to produce, refine and distribute oil. The gas engine show this year is a feature by itself. In the open air space will be engine or compressor equipment, in action, made by the following: Bessemer Gas Engine Co.; Hope Engineering & Supply Co., Climax Engineering Co., Chicago Pneumatic Tool Co., Clark Brothers Engine Co., C. & G. Cooper Mfg. Co., Miller Improved Gas Engine Co., and Foos Engine Co. Besides these there will be exhibits of oil and gas engines, trucks, cars and tractors by Buda Co., Waukesha Motor Co., Allis-Chalmers Co., Republic Truck, Mack International Motor Truck Corp., Dodge Brothers, Inc., Advance-Rumely Thresher Co., Chrysler Corp., Ford Motor Co. and Caterpillar Tractor Co. The latter will show one of its 10-ton tractors.

These and the derrick exhibits constitute the most noticeable of the out-door exhibits. Seven derricks have been erected. Two were put up by the Wertzberger Derrick Co., two by the Parkersburg Rig & Reel Co. and one each by the National Turnbuckle Derrick Co., the Braden Co. and the exposition itself.

RIVALLING the equipment exhibits will be the scientific part of the show. It was originally planned to occupy space in one of the main buildings, but the committeemen charged with getting the exhibit together worked so diligently that the management was compelled to put up a new building. It is 60 by 160 feet and will be comfortably filled. There

Key to Photographs of Exposition Directors

TULSA, Sept. 7.—The official family, officers and directors, of the International Petroleum Exposition, number 38 and all are quite intimately connected with the oil industry, either as executives of companies, manufacturers and distributors of equipment, publishers of oil trade journals or bankers in the oil country. It is expected that all of them will be in Tulsa for the opening of the exposition, Sept. 24. The 30 whose pictures appear on the opposite page are:

No. 5—President W. G. Skelly, president, Skelly Oil Co. 1—Vice President Alf G. Heggem, president, Oil Well Improvement Co., and president, Tulsa Chamber of Commerce. 2—Vice President Frank Hinderliter, president, Hinderliter Tool Co. 3—Treasurer J. J. McGraw, president, Exchange National Bank, Tulsa. 4—General Manager J. Burr Gibbons, president, Hofstra Mfg. Co. 6—Secretary William Holden, secretary, Tulsa Chamber of Commerce. 7—A. F. Bourne, secretary-treasurer, Oklahoma Iron Works. 8—Jacob France, president, Mid-Continent Petroleum Corp. 9—A. W. Leonard, vice president, Devonian Oil Co. 10—J. Edgar Pew, vice president, Sun Oil Co. 11—W. M. Bovaird, secretary-treasurer, Bovaird Supply Co. 12—Walter Miller, vice president, Marland Refining Co. 13—Waite Phillips, president, Philmac Oil Co. 14—Ernest Nicklos, vice president, The Texas Corp.

15—J. S. Sidwell, assistant superintendent, Prairie Oil & Gas Co. 16—H. V. Foster, president, Indian Territory Illuminating Co. 17—D. D. Wertzberger, president Wertzberger Derrick Co. 18—Howard N. Cole, vice president, Pure Oil Co. 19—R. C. Sharp, president, Oklahoma Natural Gas Co. 20—John M. Lovejoy, vice president, Amerada Petroleum Corp. 21—Fred Insull, president, Public Service Co. of Oklahoma. 22—Robert F. Garland, independent oil producer and discoverer of the famous Seminole pool. 23—J. M. Hayner, president, Hayner-Reeves Co. 24—Victor H. Smith, vice president, North American Car Corp. 25—Ray L. Dudley, president, Gulf Publishing Co. 26—P. D. Hayes, assistant cashier, Exchange National Bank of Tulsa. 27—O. C. Staples, manager, machinery department, Frick-Reid Supply Co. 28—A. A. Beard, general superintendent, Tidal Oil Co. 29—Clyde Alexander, vice president, Phillips Petroleum Co. 30—George A. Dye, vice president, H. F. Wilcox Oil & Gas Co.

Others directors not shown in the picture are Ralph B. Pringle, vice president, Independent Oil & Gas Co.; Clyde Pape, secretary-treasurer, Selby Oil & Gas Co.; C. P. Dimit, vice president, Gypsy Oil Co.; Walter Gray, president, Jarecki Supply Co.; Robert W. Egan, general manager, Oil & Gas Journal; J. M. Post, manager, Oil Well Supply Co.; Warren C. Platt, editor and publisher, NATIONAL PETROLEUM NEWS, and R. A. Griffith, vice president, Sinclair Oil Co.

was so much to do in assembling the exhibit that the exposition board employed Kent Kimball, geologist, to take charge and get the job done properly.

SEVERAL scientific instrument makers have space in the new building. They are the Refiners Supply Co., the Foxboro Co., the C. J. Tagliabue Mfg. Co., the Rectigraph Co., Westcott & Greis, Brown Instrument Co., and the Taylor Instrument Co. The Oklahoma Natural Gas Co. will exhibit miniature drilling outfits and lease models, replicas of the Drake tools and several other things of historic interest in the new building.

The main scientific display will be installed and directed by the exposition management. There will be more than $25,000 worth of instruments used in locating possible oil producing structures and in testing oil, its products and natural gas. There will also be precision instruments used in the manufacture of drilling equipment.

Through George S. Rollin, Mid-Continent manager of the Roxana Petroleum Corp., arrangements were made for the Roxana to lend a torsion balance and a seismograph for display. These instruments are guarded no less carefully than Col. Lindbergh watches over his ship, hence the Roxana is sending one of its geologists to have constant charge.

The geological display will be unusually large this year. The U. S. Geological Survey, the Oklahoma Geological Survey, the Missouri School of Mines, and Frank C. Greene, chief geologist of the Skelly Oil Co., have given liberally of their collections for the show. Many maps of the Mid-Continent fields have been obtained and H. W. McDonald, Prairie Oil & Gas Co., has made relief models of the Seminole and Garber fields, showing the top of the Wilcox sand.

THE Bureau of Mines will have a large exhibit which includes a glass working model of the air life method. The bureau is sending its mine rescue car and will give demonstrations of first aid and safety work. This will supplement the first aid contests, in which 27 teams have been entered.

EVERY type of heavier-than-air craft and one army "blimp" will be seen at the exposition. Leading all others in interest, of course, is Col. Lindbergh, who will arrive on Sept. 30 for a one-day stay. Of great interest, however, is the big tri-motored Stanolind, owned by the Standard Oil Co. of Indiana, which will arrive on Sept. 28 with Col. R. W. Stewart, chairman of the board; vice-presidents Jackson, McElroy and Bullock, and possibly other officials. Four officials of The Texas Co. will make the trip from Houston in a Ryan monoplane. Vice-president B. E. Hull of the Texas Pipe Line Co.; Vice-president G. L. Noble, The Texas Co.; Assistant Sales Manager J. S. Leach, and General Superintendent F. P. Dodge will be the passengers. All told, more than 20 visiting ships will be on hand and eight locally owned planes will take part in the program.

Exhibitors at International Petroleum Exposition

Advance-Rumely Thresher Co.
Geo. B. Allan & Co
Allis Chalmers Mfg. Co.
Aluminum Corp. of America
American Car & Fdry. Co.
American Fomon Co.
Andrews Steel Co.
Armstrong Bros. Tool Co.
Armstrong Machine Works
Atlas Lumnit Cement Co.
Robert N. Atmore Co.
Automatic Electric, Inc.
B. & A. Specialty Co.
Baird Tool Works
Barber Greene Co.
Barco Mfg. Co.
Barnsdall Corp.
Barton Manning & Warner Co.
Bennett Pumps Co.
Bessemer Gas Engine Co.
Bethlehem Fdry. & Machine Co.
Billings & Spencer Co.
Binks Spray Equipment Co.
Boviard Supply Co.
Braden Steel & Winch Co.
C. F. Braun & Co.
H. H. Breene Oil Field, Inc.
The Bristol Co.
Brooks Engineering Co.
Brown Instrument Co.
Brown Tool Co.
Buckeye Traction Ditcher Co.
Buda Co.
Burt Corporation
Butler Portable Steam Hammer
Cameron Tool & Supply Co.
C. F. Camp Co.
J. A. Campbell
H. W. Cardwell
Casey Hedges Co.
Caterpillar Tractor Co.
Celotex Co.
Chaplin Fulton Mfg. Co.
Chicago Bridge & Iron Works
Chicago Pneumatic Tool Co.
Clark Bros. Co.
Clear Vision Pump Co.
Climax Engineering
Close-To-Nature Co.
Coen Co.
Coleman Motors Corp.
Creeper Wheel Co.
C. & G. Cooper Co.
Crane Packing Co.
Dearborn Chemical Co.
G. M. Davis Regulator Co.
DeLaval Separator Co.
De Vilbiss Co.
Devoe & Reynolds Co., Inc.
L. E. Dickson
Dow Pump & Diesel Engine Co.
Dunn Mfg. Co.
Eagle-Picher Lead Co.
Economy Pump Co.
Equipment Mfg. Co.
Evansville Malleable Castings Co.
Falk Corp.
Federal Malleable Co.
Federal Supply Co.
Fluor Construction Co.
Foamite-Childs Corp.
Foos Engine Co.
Ford Motor Co.
Foxboro Co., Inc.
France Packing Co.
Garlock Packing Co.
Gas Engineering & Con. Co.
Gaso Pump & Burner Co.
General Electric Co.
General Motors Truck Co.
General Woodwork Corp.
Gilbert & Barker Mfg. Co.
Goulds Pumps, Inc.
Griscom Russell Co.
Gulf Publishing Co.
Gustin-Bacon Mfg. Co.
Hallimurton Oil WDell Cement Co.
C. M. Heeter Sons & Co., Inc.
Hercules Motors Corp.
Highland Body Mfg. Co.
Highway Trailer Co.
Hill Hubbell & Co.
Hinderliter Tool Co.
Hollow, Geo. O.
Hope Engineering & Supply Co.
Hopkins Motor Co.
Hopper Winch Co.
The Howards
Howell Valve Co.
Hudson Wire & Iron Co.
Hutchinson Engineering Works
Illinois Eng. Co.
Insulating Products Co.
International Harvester Co.
International Filter Co.
Iverson Tool Co.
Kemper Thomas Co.
Kennedye-Plumb Corp.
Keystone Driller Co.
Kohler Co.
Larkin & Co.
Leland Truck & Equipment Co.
Linde Air Products Co.
Lufkin Fdry. & Machine Co.
Lunkenheimer Co.
McClatchie Mfg. Co.
Mack International Motor Truck Corp.
Magneto Ignition Corp.
Maloney Tank Mfg. Co.
Manzel Brothers Co.
Marland Refining Co.
Martin Wagon Co.
Mason Regulator Co.
Merco Nordstrom Valve Co.
Metric Metal Works
Mid-Continent Map. Co.
Mid-Continent Petroleum Corp.
Miller Comb. Bailer & Pump Co.
E. E. Miller
Miller Improved Gas Engine Co.
J. L. Miller & Carl Ewit
Mine Safety Appliances Co.
W. C. Nabors Co.
National Brake & Electric Co.
National Meter Co.
National Petroleum News
National Tank Co.
National Tank Seal Co.
Neilson Mfg. Co.
National Turnbuckle Derrick Co.
Newton Process Mfg. Co.
Neumeyer & Son, A. E.
Niles Tool Works Co.
North American Tank Car Corp.
Norval & Dial, Inc.
Wm. W. Nugent & Co.
R. D. Nuttall Co.
Oakite Products, Inc.
Walter O'Bannon Co.
Ohio Steel Fdry. Co.
Oil & Gas Journal
Oil Age Publishing Co.
Oil City Iron Works
Oil Conservation Engineering Co.
Oil Field Engineering
Oil Well Improvement Co.
Oklahoma Engineering & Foundry Co.
Oklahoma Iron Works
Oklahoma Natural Gas Co.
Oklahoma Rig & Supply Co.
Oklahoma Steel Castings Co.
Parkersburg Rig & Roel Co.
Parsons Co.
Peerless Supply Co.
Permutit Co.
Petroleum Electric Co.
Pittsburgh Equitable Motor Co.
Pittsburgh Steel Products Co.
Wm. Powell Co.
Power Mfg. Co.
Power Plant Equipment Co.
Prairie Oil & Gas Co.
Pyle National Co.
Pyrene Mfg. Co.
Quigley Furnace Spec. Co.
Quimby Pump Co.
Reading Steel Casting Co.
Rectigraph Co.
Reading Iron Co.
Reading Steel Casting Co.
Rectigraph Co.
Refinery Supply Co.
Republic Truck Sales Corp.
Ridge Tool Co.
Ryan Equipment Co.
Ryan Motor Co.
Scientific Research Association
Solden Sales & Service
Shaffer Specialty Co.
Shaffer Tool Works
Sherwin Williams Co.
Shreveport Chemical Co.
Sivyer Steel Casting Co.
Skelly Oil Co.
Skinner Bros. Belting Co.
Smith Separator Co.
Snap On Wrench Co.
P. J. Sonner Gas Burner Co.
Southern Mill & Mfg. Co.
Southwestern Engineering Corp.
Spang & Co.
Specialty Oil Tool Co.
Spencer Trailer Co.
Stanley Bolting Co.
Standard Lift Co.
Star Drilling Co.
Star Mfg. Co.
Staytite Co.
Stearns Rogers Mfg. Co.
Stefco Steel Co.
Stoody Products Sales Co.
Sullivan Co.
Sun Oil Co.
Surface Equipment Co.
Wm. J. Swoot Co.
C. J. Tagliabue Mfg. Co.
Taylor Instrument Co.
Templeton Konley & Co.
The Texas Co.
Thrift Corp.
Timken Roller Bearing Co.
Traction Machine Co.
Tulsa Boiler & Machinery Co.
Union Machine Co.
United Carbon Co.
United Iron Works
Van Leer Spout Co.
Henry Vogt Mch. Co.
Waukesha Motor Co.
Wailes Dove Hermiston Corp.
Welders Supply Co.
Wollsville Fire Brick Co.
West American Rubber Co.
Westinghouse Electric & Mfg. Co.
Westcott & Greis, Inc.
Whealton & Townsend, Inc.
Whitney Metal Tool Co.
E. B. Wiggins
J. H. Williams & Co.
Williamette Winch & Hoist Co.
Williamson Motors Corp.
Wise & Schlegel
Worthington Pump & Machinery Co.
Young Engine Corp.
Zero Hour Torpedo Co.

N. P. A. Members Urged to Set Quota For Work to be Done in 5 Years

By V. B. Guthrie
MANAGING EDITOR

ATLANTIC CITY, Sept. 16

THAT the National Petroleum Association set a quota for work its members want the organization to accomplish in the next five years, in much the same way that business houses establish a sales or production quota to direct their future course, was urged by retiring President O. P. Keeney at the Twenty-fifth anniversary meeting of the association here Sept. 14, 15 and 16.

His suggestion was inspired from the recital of the many benefits, not only to members but to the oil business generally, that the National Petroleum Association—"pioneer in the adventure of co-operation in the oil industry," it was termed by General Counsel Fayette B. Dow—has accomplished during its 25 years' existence.

"Quotas have proved universally successful in stimulating activities of individual businesses, why would they not do as well in association work?" Mr. Keeney asked. "Then we could have another anniversary meeting five years hence and see how close we came to accomplishing our quota."

There were many high lights and bright spots in this silver anniversary meeting, and one hesitates to commence their chronocling for fear that some may be omitted in the telling, or those that seem of greater importance to others may come late in the list. What most impressed this writer was that these men and the staff of this association were planning their work for the future without reference to present conditions of the oil industry, except as they form a guide to its future activities.

There was only a passing comment or two by speakers to present distressing markets. There was no speculation as what the rest of the year might bring, or the effect of present general market conditions on individual companies. These refiners were planning constructive association work along various lines that will prove of lasting benefit to their members.

One who listened, during the reminiscencing on the program, to some of the older members of the National Petroleum Association as they told of some of the things that had happened during its early history, of the long fight with the railroads against rebating, of markets cut off overnight, of crude supplies discontinued on a day's notice, could hardly help feeling that its members regard present conditions as only an incident in industrial life, and only to be reckoned with as any set of business conditions would be considered.

The new president of the association is E. M. Lyons, vice president of the Tiona Refining Co., Clarendon, Pa. While proferred the office again, Mr. Keeney refused to accept, having been president from 1924. Mr. Lyons is at present president of the National Petroleum Mutual Fire Insurance Co., which was organized through the association. His activity in the Pennsylvania refining field dates back prior to the organization of the association and he became identified with association work in 1907. He was second vice president from 1919 to 1921 and has lately been trustee in charge of trade and commerce.

MR. KEENEY and Samuel Messer, Independent Refining Co., Oil City, a former president, were both made honorary members of the association at this meeting.

The active business program of this meeting was presented through reports of the trustees for the various departments.

H. H. Greene, Kendall Refining Co., Bradford, reporting for the department of manufacture, in the absence of B. B. Stroud, trustee, advocated the establishment by the association of a research program to work towards finding new uses for what are now regarded as by-products of the refinery, petrolatums, fuel oil and kerosene, for example. Mr. Greene said better utilization of these products would allow the refiner a more stable market, which is sometimes now below the cost of manufacture. He said the director of research of Pennsylvania State College had been asked to outline a program for the association to consider.

Mr. Lyons, presenting the report for the department of trade and commerce, urged greater co-operation by the member refining companies in the submission to the association of data on plant operations, including output, shipments and stocks, in order that these might be compared with the Bureau of Mines report for the eastern districts and serve as a guide to individual plants in directing their own operations.

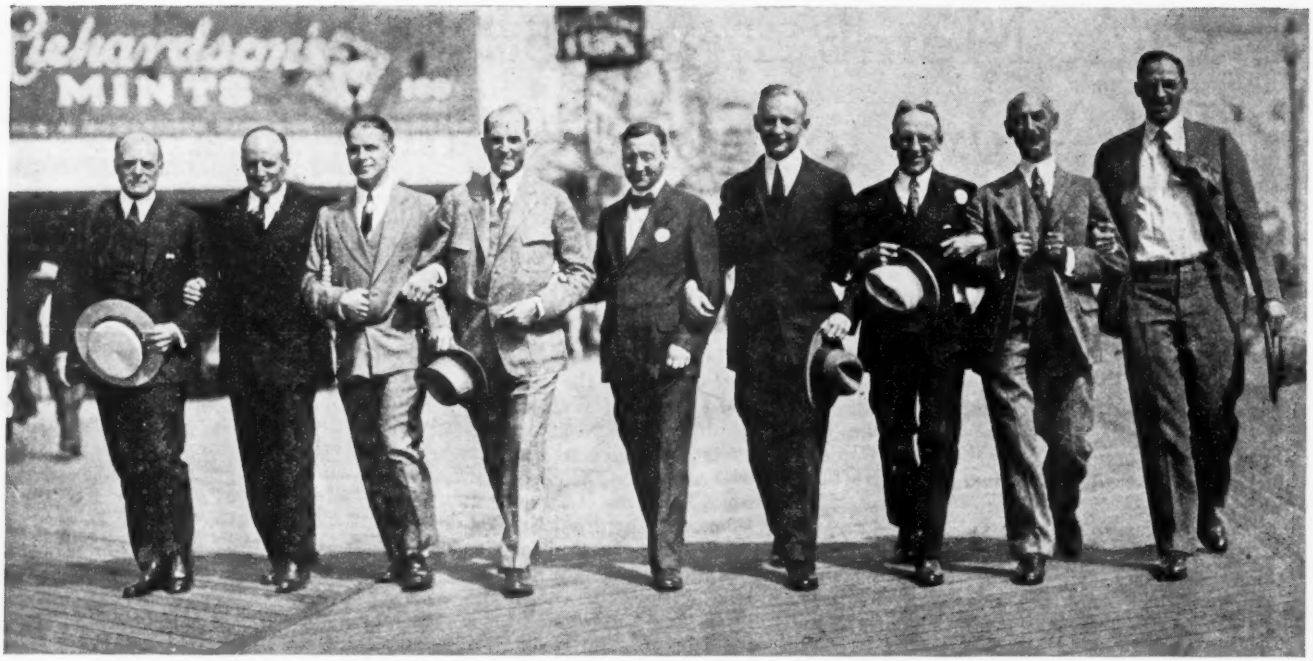
A. W. Scott, Empire Oil Works, Oil City, reporting for the department of standards and tests, said group organizations of chemists of member companies were now functioning in Warren, Bradford, Oil City, Pittsburgh-Butler, West Virginia, and Philadelphia refinery groups. He told of the work carried on the last year in testing samples of oils at member laboratories to obtain more uniform testing. He said visits to plants by chemists in groups would be continued.

P. S. Tarbox, Independent Refining Co., Oil City, trustee in charge of economics, accounting and statistics, presented a paper on the value of a good cost record system to the refinery executive and said the association had two alternatives to consider in improving its cost accounting methods. One is to wait for the American Petroleum Institute to complete the work on its uniform accounting system for the entire oil industry, which he said could not be done inside two to three years; the other to proceed in the next few months to work out a system adaptable to the needs of the Pennsylvania group refiners.

MORE support by plant executives of the work on fire prevention at refineries carried on by the Fire Marshals' Association was urged by R. A. Wotowitch, Henry L. Doherty & Co., New York, trustee in charge of welfare and insurance. Organized by groups in various refining districts these fire marshals, men from within the plants, serving voluntarily, inspect plant properties regularly to re-

Limited Number of N. P. A. Histories For Sale

THE National Petroleum Association announces there are remaining a small number of copies of the history of the association, written by Fayette B. Dow, general counsel, and presented to members at the silver anniversary banquet in Atlantic City last week. The histories will be sold for $2 each. The books contain almost 100 photographs of past and present officers and trustees of the association. They can be obtained from Herbert G. Eaton, recording secretary, Superior Oil Works, Warren, Pa.



Trustees of the National Petroleum Association swinging down the board walk. Frank B. Fretter, National Refining Co., Cleveland; Fayette B. Dow, general Counsel, N. P. A., Washington; H. H. Greene, Kendall Refining Co., Bradford; E. M. Lyons, Tiona Refining Co., Clarendon, Pa., newly elected president of the N. P. A.; Herbert G. Eaton, Superior Oil Works, Warren, Pa., recording secretary of the N. P. A. since its organization; O. P. Keeney, Keeney Oil Co., New York, retiring president of the N. P. A.; P. S. Tarbox, Independent Refining Co., Oil City; G. C. Davison, Tri State Refining Co., Kenova, W. Va.; A. W. Scott, Empire Oil Works, Oil City

duce fire hazards. It is now proposed that they take up accident prevention work as well. As showing the need for more support of this work by plant executives, Mr. Wotowitch said company purchasing agents, to save money, sometimes buy faulty equipment, which the fire marshals recognize as adding to the fire or accident hazard at the plant.

Houston Dunn, manager, National Petroleum Mutual Fire Insurance Co., spoke of the value to the isolated refinery of the reports now coming from the organized groups.

FRANK B. FRETTER, president, National Refining Co., Cleveland, and trustee in charge of the department of traffic and transportation, outlined the work of his group, saying the traffic work of the association could be made self supporting through reparations collected from the railroads on overcharges.

Speaking on "The Advantages of a Common Enemy" at the afternoon session Sept. 15, W. T. Holliday, general counsel, Standard Oil Co. of Ohio, said the common enemy of the oil industry was public misunderstanding, and that this misunderstanding was brought about through the faulty and inaccurate discussion of the economics of the oil industry by general writers. He advocated that the industry generally find some means to make the true economics of the industry more widely available. His address aroused considerable favorable comment.

With the exception of the address by Mr. Holliday and the presentation by Willis Crane, traffic attorney for the association, of his report on railroad rate matters, the Sept. 15 afternoon session was given over to reminiscences. Mr. Fetter, himself an oldtimer in the association work, presided. R. D. Benson, a director of the Tide Water Oil Co., told of the early days of the Pennsylvania oil fields. W. D. Todd, Warren, chairman of the first executive committee of the association, spoke from personal recollections of its first president H. A. Jamieson. William Muir, Warren, president from 1912 to 1917, told of the work of C. D. Chamberlin, formerly general secretary, now retired. This recital of what the "Judge" meant to the association could hardly be confined to Mr. Muir, since a thread of affection for him ran through the remarks of many speakers; perhaps it should more properly be referred to as a bond, rather than as a thread.

OTHERS who responded on this part of the program were G. P. Brockway, Seneca Oil Works, Warren; Herbert G. Eaton, Superior Oil Works, Warren, secretary of the organization meeting and recording secretary since, to whom Mr. Dow referred, in his history of the association, as adding to his notes his own comment "and rightly too" after the remarks of some speaker at a meeting with whom he strongly concurred. Frank F. Moore, McKean County Refining Co., Bradford, spoke of Col. U. G. Lyons, past president, now deceased. C. L. Suhr, Pennzoil Co., Oil City, was called on extemporaneously.

The high point in the meeting to many was the silver anniversary banquet at the Shelburne the evening of Sept. 15. Here was presented to the guests the history of the National Petroleum Association written by Mr. Dow, replete with pictures of members past and present—the human story of one of the oldest trade associations in the country, organized 25

25th Anniversary Pictures

A feature of the next issue of National Petroleum News will be the exclusive photographs of oil men attending the silver anniversary meeting of the National Petroleum Association in Atlantic City, Sept. 14, 15 and 16. These photographs were taken along the famous boardwalk.

Flynn Heads Pennsylvania Crude Association

ATLANTIC CITY, Sept. 15.—J. P. Flynn, oil producer, Sistersville, W. Va., was elected president of the Pennsylvania Grade Crude Oil Association at a meeting of the directors at the Traymore hotel yesterday. He replaces C. G. Dorn, Forest Oil Co., Bradford.

I. H. Shearer, Kendall Refining Co., Bradford, was elected vice-president, replacing Mr. Flynn. E. M. Lyons, Tiona Refining Co., Clarendon, was re-elected recording secretary and Samuel Messer, Emlenton Refining Co., Emlenton, treasurer. R. J. Alexander continues as secretary.

years ago in an effort to fix kerosene prices. Mr. Dow was toastmaster and the evening was given over to entertainment.

At the morning session Sept. 15 these representatives of other oil associations brought greetings to the National Petroleum Association: W. R. Boyd, Jr., assistant general counsel, for the American Petroleum Institute, G. G. Woodruff, Roxana Petroleum Corp., St. Louis, a director, for the Western Petroleum Refiners Association, and James A. Gilmore, secretary, for the American Oil Men's Association. L. V. Nicholas, president, Independent Oil Men of America, responded by telegram.

Except the president officers of the National Petroleum Association were re-elected. They are: P. S. Tarbox, Independent Refining Co., Oil City, first vice president; H. A. Logan, United Refining Co., Warren, second vice president; Mr. Dow, general counsel; C. D. Chamberlin, advisory counsel; Willis Crane, traffic attorney; Herbert G. Eaton, recording secretary, and G. B. Hunter, Emlenton Refining Co., Emlenton, treasurer.

With the exception of B. B. Stroud, the old board of trustees were re-elected. G. C. Davison, Tri State Refining Co., Kenova, W. Va., was elected to his place. Other trustees are: Fred G. Clark, Fred G. Clark Co., Cleveland; Sheldon Clark, Sinclair Refining Co., Chicago; Frank B. Fretter, National Refining Co., Cleveland; Howard H. Greene, Kendall Refining Co., Bradford; H. A. Logan, United Refining Co., Warren; E. M. Lyons, Tiona Refining Co., Clarendon; T. J. Hilliard, Waverly Oil Works, Pittsburgh; O. P. Keeney, Keeney Oil Co., New York; A. W. Scott, Empire Oil Works, Oil City; P. S. Tarbox, Independent Refining Co., Oil City, and R. A. Wotowitch, Cities Service, New York.

Credit for the successful program and attendance was due in good part to the efficient work of members in preparation. Mr. Lyons was in charge. Mr. Clark and S. P. Worthington, Tiona Refining Co., Philadelphia, had the banquet in charge.

"Doc" Cook Seeks Freedom

HOUSTON, Sept. 15.—Dr. Frederick A. Cook, promoter and Arctic explorer, who was convicted of oil stock frauds at Forth Worth and sentenced to serve 14 years, nine months, at Leavenworth, has petitioned the Supreme Court of the United States to decide whether the federal district court of northern Texas had authority to place him on probation. The federal district court gave Dr. Cook clemency over objection of government attorneys several months ago. The circuit court of appeals at New Orleans later reversed the district court.

Presence of Water in Yates Field Proved

By Telegraph

HOUSTON, Sept. 20.—First positive proof of hydrostatic pressure backing up oil in Yates field of Pecos county came Sept. 19, when important intrusions of salt water occurred in two east edge wells. Gulf Production Co.'s No. 1 Thompson, which last week extended the field across the river into section 71 Crockett county, started making 5 per cent water while pinched to 30 barrels an hour. At the end of the third hour after water first showed it made 20 per cent brine and later was shut in.

Maximum production of the well had been 750 barrels an hour at completion depth of 987 feet. The Pecos river bed completion of Allsman and Bell, which the Gulf well virtually offsets, made 4 per cent water while flowing 176 barrels of oil daily.

The very significant incursion of water in these wells does not mean the Yates field will be reduced to impotency by inroads of brine in the immediate future. The affected wells are approximately 277 feet lower on the sub-surface structure than the average wells in the high part of the field.

Field engineers will find no occasion for the present to revise their estimates of possibly 1,400 acres of productive ground in the field averaging 15,000 to 20,000 barrels per acre recovery. They consider proved, by the development of brine in edge wells, however, the long suspected condition wherein a water table backs up the oil and provides pressure in the underground reservoir similar to that found in the south country fields of Mexico.

When the field is opened up, therefore, it may be expected that wells low on the structure and adjacent to the water level will soon develop brine. Wells near the top of the structure will continue to produce large quantities of crude in line with the effect of Yates field proration activities until the constant rise of the water table brings about conditions somewhat similar to those experienced in Mexico.

Announce Program for 4 States Meeting

TULSA, Sept. 17.—Topics to be discussed at the meeting of jobbers from four states in Kansas City Oct. 4, 5 and 6 were announced by George S. Allee, president of the Missouri Oil Men's Association. Names of speakers will be published within the next few days.

Topics include discussion of the gasoline of tomorrow; automobiles of tomorrow; lubricants and lubrication; fire hazards and fire protection; credits and collections; merchandizing and sales promotion help, and publicity; should a country jobber advertise, and if so, how? An interesting feature of the program will be the observations of a motorist on a 16,000 mile automobile trip. Arrangements have been made for reduced fares to the convention on the certificate plan.

The Missouri Oil Men's Association will hold its annual meeting for the election of officers at 10:30 a. m., Oct. 4, just before the four state meeting starts. States joining in the meeting are, Kansas, Nebraska, Iowa and Missouri.

Mr. Allee announces that C. A. Knutson of Clear Lake, Ia., has been procured as a luncheon speaker. Mr. Knutson is highly recommended by Mr. Allee as well as by M. L. Long, secretary of the Iowa jobbers. It has been announced that Roy Reed of Kansas City, chairman of the entertainment committee for the meeting has booked several good acts of vaudeville and that the athletic committee is promoting a good fistic combat.

Fight Station Inspection Fee

TULSA, Sept. 17.—Service station owners in Kansas City have begun a court fight to prevent that city from collecting an inspection fee of $150 per year for every service station in the city. Application for a restraining order has been filed by the firm of Haberland and Prine, owners of a station at 44th and Prospect. The inspection fee ordinance was passed a year ago but oil companies did not make a fight when the city agreed to cut the fee to $60 in 1927. The present suit was filed when the city failed to amend the ordinance.

Bulletin

TULSA, Sept. 20.—Action of the Blackwell Oil & Gas Co. in opening to full production its three wells in the Little River pool brought possibility of state corporation commission action to compel compliance with the order limiting production to 1,000 barrels daily per well. The Blackwell opened its wells Monday night. Umpire Collins and members of the proration committee were to confer Wednesday with the corporation commission as to what action is to be taken.

Form Regional Committees to Broaden Study of Gas Conservation

TULSA, Sept. 17

TO BROADEN the scope of its inquiry on the value of natural gas in the conservation and production of petroleum the American Petroleum Institute committee of seven in meeting at Colorado Springs Sept. 11 and 12 created a technical sub-committee of four divisions. The technical sub-committees will make an intensive study of conditions in the four regions, meet at Ponca City Oct. 17 to assemble the data, and prepare a report on conclusions to be made when the committee of seven reconvenes in Ponca City Oct. 19.

Four regions involved, and the respective chairmen are Pacific coast, M. E. Lombardi, in charge of production for the Standard Oil Co. of California; Rocky mountain territory, Max W. Ball, Denver; Texas and Louisiana, John R. Suman, director in charge of production for the Humble Oil Co.; Oklahoma and Kansas, Dr. W. P. Haseman, in charge of research department of Marland Oil Co. Earl Oliver, of Earl Oliver & Co., Ponca City, is general secretary. The Appalachian region was omitted as there was no representative from this section at the Colorado Springs meeting, but may be included later.

Organization details for collecting this data have been left with the four regional chairmen who will select their co-workers. The regional chairmen were authorized to make a systematic study of the available knowledge in that region, selecting companies and individuals fitted for this task. Outstanding scientists, apart from petroleum engineers, will probably be called to assist in this intensive study for the next five weeks.

In organizing the Oklahoma and Kansas region, Dr. Haseman Sept. 17 sent out a letter to those invited to participate in this district, explaining the history of the development of the committee of seven and of the recent technical sub-committee, and calling a meeting for his region at the Marland offices in Ponca City Sept. 23.

DR. HASEMAN'S letter of invitation sums up the opinion developed at the Colorado Springs meeting, stating that "while natural gas is believed to play a very important part in the production of oil, yet remarkably little is known about its exact functions and the best means of utilization, also that it is highly important to the industry that a more thorough study be instituted and the facts therein developed be made available to guide the industry in its present stage of evolution.

"It was also recognized that because of the necessarily cooperative manner in which the application of gas to the production of oil must be handled that no particular advantage is attained to any one company in retaining to itself knowledge about the functions of gas, since the same could not be applied unless like knowledge and opinions are held by others whose cooperation is sought. This information differs, for instance, from knowledge of improved geological methods whereby one company might have advantages over another by keeping its information to itself. It appears clear that the greatest good to the individual company can be accomplished only in proportion to the knowledge regarding the function of gas being widely disseminated so that there may be unanimity of opinion as to the best methods of applying it. Consequently it was readily agreed by the companies present that they would lend their technical experts and supply their technical data for the purpose of making a comprehensive study of this problem; that they would lay the same before the industry generally and before the Institute in particular."

The Colorado Springs meeting was called by Chairman E. W. Marland. Committeemen present, besides Mr. Marland, were S. H. Keoughan, president of the Continental Oil Co.; L. P. St. Clair, vice-president, Union Oil Co. of California; J. Edgar Pew, vice-president, Sun Oil Co.; Henry McGraw, vice-president, Gypsy Oil Co., and Wallace Pratt, of the Humble Oil & Refining Co., who represented W. S. Farish, president of the Humble. Thomas A. O'Donnell, chairman of the board of the California Petroleum Corp., was absent.

OTHERS who were present to hear and participate in the discussion were E. W. Clark, president of the American Petroleum Institute; R. L. Welch, general counsel, American Petroleum Institute; George Marland, of the Marland Oil Co.; W. A. Moncrief, Marland Oil Co.; Earl Oliver, Ponca City; Max Ball, president, Argo Oil Co.; M. E. Lombardi, Standard Oil Co. of California; John Suman, Humble Oil & Refining Co.; James York, The Texas Co.; Fred W. Freeman, The Texas Production Co.; W. H. Ferguson, vice-president, Continental Oil Co.; E. T. Wilson, chairman of the board, Continental Oil Co.; James Duce, state oil inspector of Colorado and Assistant Attorney General Dean of Colorado.

Chairman Marland, in opening the meeting, announced that the purpose of the session was to develop the facts regarding the fullest utilization of gas in the production of oil, such data to be placed before legal counsel for the committee as an aid to him in advising the committee before it prepares its final report to the Institute directors. This committee was appointed last December at the annual meeting of the A. P. I. in Tulsa. It met in January and prepared a resolution, which, if adopted by the Institute directors would have pledged that body to support state legislation to effect gas conservation. The resolution was discussed by the executive committee of the Institute in May and this body asked the committee of seven to continue its studies and to employ legal aid. Accordingly, Charles Evans Hughes was retained to study the question and give his opinion as to the form of statute required, if it should be decided to go the full distance in endorsing state legislation.

Several of the technologists who were present at Colorado Springs gave their views on gas conservation. It was felt by the committee that the scope of the inquiry should be broadened, hence the appointment of the technical sub-committee.

F. W. FREEMAN, of The Texas Production Co., Denver, brought to the attention of the committee of seven a subject which he said demanded action. He discussed the heavy burden now imposed upon operating companies by the royalty owners and said the oil industry should seek revision of its lease contract forms. One suggestion he made is that contracts be so drawn as to provide for trustee to act for all royalty owners where the interests are divided among a number of persons. It is well known that the operator is frequently forced to pursue a policy of development that is against his wishes and against good operating practice because royalty owners are difficult to bring into agreement, particularly in new fields.

Following Mr. Freeman's suggestion, a sub-committee was appointed to study existing lease forms and suggest remedial changes. This committee consists of James A. Veasey, general counsel, Carter Oil Co., Tulsa; D. A. Richardson, counsel for Marland Oil Co., Oklahoma City and Rush Greenslade, Gypsy Oil Co., Tulsa.

Low Refinery Prices Causing Plants To Shut Down or Cut Runs

By J. C. Chatfield
N. P. N. STAFF WRITER

TULSA, Sept. 17

LOW refinery markets in the Mid-Continent field have resulted in a definite curtailment of refining operations there within the past few weeks. Current indications are that a further reduction in operations will be made in the near future unless there is a marked improvement in prices for refined oils.

Within the past week the management of the Imperial Refining Co. has decided to shut down both its crude stills and cracking plant at Ardmore until it can operate profitably. This company has a 7,000 barrel skimming plant and a 2,000 barrel cracking plant at Ardmore. Regular customers of the company will be taken care of through the company's refinery at El Dorado, Ark.

The Imperial's decision to close down its Oklahoma plant is the first announcement of that nature to be made in this state. A number of plants have been closed in north Texas, however, for similar reasons.

The Anderson Prichard Oil Corp. has closed its refinery at Wichita Falls which it operates under lease. This company is continuing the operation of its plants at Colorado, Tex. and Cyril, Okla. The Wichita Falls plant is a 3,000 barrel skimming plant which has been used largely for the production of specialty products.

The Humble Oil & Refining Co. has closed its 4,000 barrel skimming and cracking plant at Burkburnett, Tex. At Wichita Falls the Primrose Refining Co. has closed its skimming plant. The Iowa Park Producing and Refining Co. has announced that it is contemplating closing its 1,500 barrel skimming plant at Iowa Park as soon as it has taken care of its present obligations.

Refiners in North Texas reporting to NATIONAL PETROLEUM NEWS each week on their current operations showed an average of 67,763 barrels of crude oil per day charged to stills during July and August. For the week ending Sept. 9, the same group of plants reported a daily average run of 61,958 barrels of crude per day, a reduction of 5,805 barrels daily average.

Crude runs of all reporting refineries in the five Mid-Continent states constituting about 60 per cent of the operating inland group of plants, averaged 285,396 barrels per day during the months of July and August. For the week ending Sept. 9 this group of plants reported average crude runs of 279,875 barrels, a reduction of 5,521 barrels daily average. This was a little less than the reduction reported by north Texas operators.

It is expected generally that curtailment programs will spread from Texas into Oklahoma, Kansas and North Louisiana and Arkansas within the next few weeks bringing crude runs well below their current level. At the present moment the heat wave throughout the middle west has stimulated demand to such a high point that refiners are drawing heavily on their stocks of gasoline to meet their orders. In the two weeks ending Sept. 9 plants reporting to NATIONAL PETROLEUM NEWS reduced their gasoline stocks 9,400,000 gallons, the greatest reduction made in any two succeeding weeks this year.

In the four weeks ending Sept. 9, the group of reporting plants charged to stills 7,989,016 barrels of crude oil and obtained as finished products 141,237,000 gallons of gasoline, 25,359,000 gallons of kerosene, 6,708,000 gallons of stove distillate, 27,964,000 gallons of gas oil and 115,263,000 gallons of fuel oil. On the basis of these yields the return from the barrel of crude charged to Mid-Continent refineries at present on the basis of current spot markets is as shown in accompanying table.

Product	Yield %	Yield Gal. per Bbl.	Price in cents per Gal.	Yield price per Bbl.
Gasoline	*42.1	17.7	6.125	$1.084
Kerosene	7.6	3.2	4.125	.13
Distillate	1.9	0.8	3.125	.025
Gas Oil	8.3	3.5	2.5	.088
Fuel Oil	34.4	14.4	2.0	.288
Loss and other products	5.7	2.4	.....	.....
Total	100.0	42.0	.....	$1.615 blended

*Natural gasoline purchased and at the refinery not included in yield.

ASSUMING the average cost of crude oil at the well in the Mid-Continent to be $1.32 per barrel (38.0 to 38.9 A.P.I. gravity) and the average gathering and pipe line charge to be 25 cents per barrel, the delivered cost of crude oil at the refinery would be $1.57 per barrel. This would leave the refiner a margin of only 4.5 cents per barrel to cover his operating and selling costs, depreciation and interest on his investment. If the average crude cost is based on 36.0 to 36.9 gravity crude the margin would be only 8.5 cents per barrel.

In view of the large amount of light crude available in Oklahoma at the present time it appears likely that the average run by refineries is nearer 38 gravity than 36 gravity. In either case it is apparent that even the most efficient refining organization is taking a loss on current operations.

Index to Coming Meetings

Fourth International Petroleum Exposition and Congress, Tulsa, Sept. 24 to Oct. 1.

Petroleum Section, National Safety Council, Hotel Stevens, Chicago, Sept. 27 to 30.

North American Gasoline Tax Conference, Deshler - Wallick Hotel, Columbus, O., Oct. 3, 4, 5.

Big Four State Jobbers, Kansas City, Mo., Oct. 4, 5, 6.

Fuels Division, American Society of Mechanical Engineers, St. Louis, Mo., Oct. 10, 11, 12, 13.

Wisconsin Independent Oil Jobbers association, Plankinton Hotel, Milwaukee, Oct. 12.

Petroleum Division, A. I. M. E., Texas Hotel, Fort Worth, Tex., Oct. 19, 20.

Virginia Independent Oil Men's Association, Monticello Hotel, Norfolk, Va., Oct. 20, 21.

Independent Oil Men of America, Congress Hotel, Chicago, Oct. 24, 25, 26.

American Oil Men's Association, West Baden Springs Hotel, West Baden, Ind., Nov. 2, 3, 4.

Indiana Independent Petroleum Marketers Association, West Baden Springs Hotel, West Baden, Ind., Nov. 3.

American Petroleum Institute, Hotel Stevens, Chicago, Dec. 6, 7, 8.

Ohio Petroleum Marketers Association, Neil House, Columbus, O., Feb. 23, 24.

Title Suits Affect Texas Oil Lands

HOUSTON, Sept. 15.—Another valuable oil survey in Texas has become a bone of contention in title litigation. It is the 741-acre Mary Whitley tract, near Borger, in the Texas Panhandle, where an accounting is sought for $4,700,000 of oil and gas receipts by Phillips Petroleum Co., and 18 other companies and individuals. The suit, which was filed at Austin, is to determine the northern lines of the Whitley survey.

Action in the Whitley survey suit was brought partly to determine validity of claims of three of the defendants, Burt E. Hinkley, Jr., of Brownsville; E. B. Trigg and Robert E. O'Keefe of Amarillo. Hinkley and O'Keefe claim they acquired rights to oil and gas permits covering the land involved under applications made to the state land office. Trigg claims he purchased or acquired the right to purchase the land outright from the state.

Defendants are J. A. and George A. Whittenburg, Potter county; E. B. Neil, Jr., and Graham B. Johnson, Cleveland county, Okla.; Montford T. and Edward B. Johnson, Potter county; Phillips Petroleum Co.; Devonion Oil Co.; Gibson Oil Corp.; Midwest Exploration Co.; Gulf Production Co.; Marland Oil Co. of Texas; Esther P. Wiley, Roy C. Patton and Nannie Patton, Los Angeles county, Cal.; and Messrs. Hinkley, O'Keefe and Trigg.

Appeal will be taken from a Travis county district court decision in a suit involving Humble field producing properties in which the state of Texas was given a judgment of from $8,000,000 to $10,000,000. The court ruled the state correctly claims title to 265 acres of the 628 acres in a disputed tract along the south bank of the San Jacinto river in Harris county. Claims of seven oil companies and several individuals were disallowed in the district court decision, which held the state should recover production receipts dating back about 20 years, less operation costs to be determined.

The suit, which is generally known as that against "Blaffer et al," affects The Texas Co.; its one time subsidiary, the Producers Oil Co., which The Texas Co. absorbed; Louisiana Oil Refining Corp.; Gulf Production Co.; Humble Oil Co., now succeeded by Humble Oil & Refining Co.; Paraffin Oil Co.; and the old partnership of Blaffer & Farish.

With exception of The Texas Co., affected to the extent of $1,201,000, and the Producers Oil Co., $1,788,000, other defendants figure variously to the extent of $207,000 to $321,000.

Cities Service Offers New Anti-Knock Fuel

CLEVELAND, Sept. 19.—Cities Service Oil Co. Sept. 15 began to market a new anti-knock gasoline throughout Ohio, It has been named Koolmotor 6 to 1, and was developed for the new high compression motors.

Koolmotor 6 to 1 is produced by the cracking processes of Empire Refining Co., a sister Henry L. Doherty subsidiary and has an end point around 400. The gasoline is dyed green.

It is being advertised throughout the state, and service stations are decked with green pennants. Koolmotor 6 to 1 sells at a 3-cent premium over the competitive grade, or at 24 cents tax included. Other Cities Service gasoline grades remain on the market. Koolmotor 6 to 1 derives its name from the compression ratio of new type automobile engines.

OIL CITY, Pa.—A business trip through Texas and Oklahoma will bring John Reid, vice president of the Joseph Reid Gas Engine Co., with headquarters here, to the International Petroleum Exposition in Tulsa during the week of Sept. 24 to Oct. 1.

Pecos Proration Plan Formally Ratified

Staff Special

FORT WORTH, Sept. 16.—Representatives of Yates field operators, meeting in the offices of the Marland Oil Co. of Texas, Fort Worth, Sept. 16, formally ratified an agreement reached a week previously for prorating crude runs from the Pecos county district.

All representatives who are officers of their respective companies signed the agreement and others not authorized to make corporate signatures gave notice of full accession to the plan.

When it had been established that Yates field operators were in full accord with the plan to pro-rate crude runs in conformity to 44,000 barrels daily outlet, beginning Oct. 1, there remained little else for the assembly to consider than the details of handling the plan.

A field representative of the prorating committee will meet with pipeline representatives and operating men in the field late this month to take official gauges of the wells. Each well will be gauged on its open flow capacity for a two-hours period and the runs from the individual lease computed on the relation of potential production to the field total. Thereafter, gauges will be made the 1st and 15th of the month throughout the pro-ration period.

Little River Well Limit Raised to 1000 Bbls.

Tulsa, Sept. 17.—After a series of discussions, operators in the Little River pool went to the Oklahoma Corporation Commission Friday and asked for and got a modification of the order which limited production to 100 barrels per well. The new limit is 1,000 barrels.

This action was brought on partly by royalty owners who were drawn up in hostile array and partly by the difficulty of making the wells perform at all if they were pinched to the former figure. It is reported that the royalty owners who were doing most of the objecting feel better about it now, although C. L. Moss, the one who got the temporary injunction in the Seminole district court against the Indian Territory Illuminating Oil Co., plans to go into the supreme court of the state to test the commission's authority to order any restriction. Judge Crump, in vacating his order on Sept. 13, five days after it had been issued gave the plaintiff 10 days to lodge his appeal in the supreme court and required supersedeas bond of $1,000.

The commission's new action is simply a modification of the original order and limits production to 1,000 barrels per well per day for 15 days, taking effect on Sept. 16 and running to Oct. 5.

A. P. I. To Consider State Taxes On Gasoline

CHICAGO, Sept. 16.—The American Petroleum Institute is going to make an investigation of the gasoline tax situation in the United States, viewing the question through the eyes of its member companies. The initial conference on the subject convenes at the Stevens hotel, Chicago, at 10 a.m., Sept. 20.

The tax conference is a committee meeting and not a general open session. A special committee on taxation has been formed, by each member of the Institute's board of directors appointing a member. Undoubtedly the directors, who are heads of companies for the most part, will appoint their own tax experts in many cases. It is expected that every section of the country will be represented in the conference. No definite time has been set for the conference to close.

The meeting was called by R. L. Welch, secretary of the A.P.I., who was one of the few representatives the oil industry had in St. Louis last fall when the tax officials of about 30 states assembled there to theorize upon co-ordination. The tax officials will meet again this fall in Columbus, O.

Seminole Air-Lifters Society Plans Bi-Weekly Meetings

TULSA, Sept. 15

THE Seminole Air Lift Society became an accomplished fact at a meeting at the Walker camp of the Indian Territory Illuminating Oil Co. last night. The 36 men attending the meeting expressed themselves unanimously in favor of the idea back of the association the exchange and dissemination of ideas and information relative to air-lift work, particularly in the Greater Seminole district. The meeting was preceded by a dinner served in the dining room of the Walker camp.

It was decided by the society that its affairs should be directed by a steering committee, rather than by the usual list of officers. This committee will decide on programs, place and time of meetings, and men to lead discussions and act as chairmen at each meeting. It consists of Dr. D. B. Dow and C. M. Rader, of the I. T. I. O. Co. and W. L. Underwood, of the Pure Oil Co. H. B. Thomson, of the I. T. I. O. Co., was elected secretary of the society.

Although regular meetings are to be held every two weeks, the next one was scheduled for Sept. 21, so as not to conflict with the International Petroleum Exposition. Subjects assigned for discussion at the next meeting was "Flow through Tubing", and "Use of Tapered Strings". Discussions are to be led by Millard Land, gas-lift engineer for the Pure Oil Co.

Subjects for future meetings were decided upon in sufficient number to last the society a year, are: "Effect of Back Pressure"; "Flow Through Tubing"; "Use of Tapered Tubing"; "Ratio of Tubing to Casing"; "Mathematics of Flow"; "Foot Pieces"; "Mechanical Efficiency as Related to Economic Efficiency"; "Combination Pumping and Flowing"; "Relative Depths of Tubing"; "Gas-oil Ratios"; "Effects of Heading"; "Use of Air vs. Gas"; "Rocking of Wells"; "Economic Limit of Gas-Lift Wells"; "Working Pressures"; "Use of Wet and Dry Gas in Flowing"; "Re-pressuring in Connection With Gast-Lift"; "Centralized as Compared With Volume Control"; "Loss of Gas in Flowing"; "Solubility of Gas in Oil"; "Ultimate Recovery From Gas-Lift Wells"; "Intermittent Flowing"; "Corrosion."

Several brief talks were made outlining benefits to be derived through exchange of information and predicting that the society would prove a big help to all concerned. W. P. Sutton, production superintendent of the I. T. I. O. Co., pledged the cooperation of his company in the exchange of ideas. C. V. Millikan, of the Amerada Petroleum Corp. told of conditions a few years ago when oil companies jealously guarded all information, and pointed to the great scientific progress made by the industry since the modern idea of "swapping information" came into being. Other talks were along similar lines.

Clifton R. Swarts and W. S. Morris of the U. S. Bureau of Mines, after stating that the society would be of help to them in gathering data, announced that work would start Oct. 1 on a special bulletin on gas-lift.

Shaffer Fighting Illinois Gasoline Tax

CHICAGO, Sept. 15.—The state of Illinois is still under fire on its 2-cent gasoline tax levied by the recent legislature. In addition to the action brought by the Chicago Motor club, which has progressed now to the state supreme court, Shaffer Oil & Refining Co. of Tulsa this week petitioned the U. S. District court to enjoin the enforcement of the law.

In the bill of complaint, Shaffer's attorneys point out that the law works a special hardship on Shaffer Oil & Refining Co. because it makes them literally bear the tax themselves on a large portion of their business instead of passing the burden of tax along to the consumer. This is because the city of Chicago and the Chicago post office are two of Shaffer's largest Illinois customers. Both customers claim exemption from the gasoline tax and refuse to pay it.

These two contracts mount into enormous gallonage and the company can not afford to absorb the tax especially because both contracts were awarded on competitive bid, so prices are low and profits small. During August Shaffer delivered 162,396 gallons of gasoline to the city's several departments. The post office contract amounted to about 200,000 gallons to be delivered during the quarter ending Sept. 30.

The oil company's attorneys are of the opinion that the Illinois gasoline tax is collectible only upon sale, but they say "Gasoline sold to the city becomes city property and city property can not be taxed under the provisions of a law passed March 30, 1872, exempting chartered municipalities from taxation." By the same reasoning they figure U. S. government property exempt from the taxation.

Shaffer's contract with the local post office is an unusual one and probably only one in the country, the price being based on the Group 3 spot price in tank cars. The price is figured at the Group 3 price plus a handling charge. Shaffer has set apart a tank at its Chicago bulk plant for the use of the post office and gasoline is shipped from the Oklahoma refinery to the Chicago post master, "government bill of lading." Thus authorities at the post office argue that the gasoline is government property from the time it leaves the refinery.

Illinois Jobbers Enjoy Golf at Galesburg

CHICAGO, Sept. 17.—Col. A. E. Inglesh, representative of the Illinois Department of Finance, was the principal speaker at the meeting of the Illinois Petroleum Marketers Association in Galesburg Sept. 14. He discussed the Illinois gasoline tax, paying especial attention to the machinery of collection and explaining the use of various forms to the oil men. There were about 90 in attendance.

E. R. Kennedy, Kennedy Oil Co., Galesburg, was the host of the Illinois jobbers and other visitors. Those who came to Galesburg by rail were escorted by Mr. Kennedy to the Sequestered Country Club grounds where the meeting was held.

After the oil men had heard the intricacies of form 5-C explained they were very largely of the opinion that they could "do it better with mashie". So they lunched together and adjourned in foursomes to the golf course, where they spent the rest of the day.

Skelly Man Gets Another Job

HOUSTON, Sept. 15.—Richard T. Lyons, west Texas division manager of Skelly Oil Co., at San Angelo, is now temporarily in charge of the Oklahoma division land department also. He is serving in the last mentioned position because of the recent resignation of H. J. Lawler.

Although retaining charge of the San Angelo office, Mr. Lyons necessarily will spend much of his time in Tulsa for the present. Besides Oklahoma, the northern division mentioned comprises the Texas Panhandle, Louisiana and Arkansas.

Mr. Lyons, who was graduated from Massachusetts Institute of Technology in 1917, has been with the Skelly organization since 1924. He was a geologist in north Texas in Ranger and Burkburnett development days. Afterward he spent a year in the Maracaibo basin of Venezuela before working in the Bristow district of Oklahoma and in east Texas.

Natural Gasoline Rates To East Attacked

Staff Special
TULSA, Sept. 17

REFUNDS on freight rates paid by manufacturers in the Mid-Continent field covering shipments of natural gasoline to eastern points were sought this week in a hearing at the Mayo hotel before Examiner Maidens of the Interstate Commerce Commission. Reparations asked extend back over several years. Five companies are pushing the complaints, the Carter Oil Co., Tidal Refining Co., Skelly Oil Co., Phillips Petroleum Co. and the Chestnut & Smith Corp.

Claims for reparations in some of the cases cover shipments made as long ago as 1921 and 1922 since several of the cases now being tried were filed in 1923. The cases have been held up pending decision by the commission of an attack on rates from northeastern Oklahoma and southeastern Kansas to Bayonne, N. J., which was made by the Phillips Petroleum Co. in Docket No. 14,995. As a result of this case natural gasoline rates were reduced 6 cents per hundred to 72 cents between the producing points mentioned and Bayonne on June 14.

In the present group of cases attacks are made on the rates to Charleston, S. C., Bayonne and Bayway, N. J., and in one of the cases to refining points in eastern Ohio and Pennsylvania. A greater number of points of origin are involved than in the case won last spring.

The weight of natural gasoline as compared with other petroleum products is playing a part in the present cases. Manufacturers are pushing their contention that natural gasoline weighs much less than other products and is entitled to a lower estimated weight than 6.6 pounds per gallon.

In both the present case and the general investigation the gasoline manufacturers are asking an estimated weight of 5.5 pounds per gallon. They assert that by being forced to pay for 1.1 pounds extra weight on every gallon of gasoline shipped they are, in effect, paying a rate 20 per cent greater than if they were shipping refined gasoline.

Strenuous objection to the consideration of estimated weights in the present cases was made by attorneys for the carriers. The shippers countered that if the lesser weight is not to be considered in the cases they will ask that reparations be made on the basis of a rate much lower than if the weight of 5.5 pounds per gallon is allowed.

An important contention of the manufacturers of natural gasoline is that their finished product still must be blended with refinery gasoline under present commercial practice before being sold as finished motor fuel. Being a raw product it is contended that rates should be lower than on finished materials.

In all of the cases which were heard this week the manufacturers were asking through one figure rates to destination in place of proportional rates made up of a combination of locals to and from the Mississippi river crossings. In support of this a large number of through rates established by the Interstate Commerce Commission were cited as precedents.

For the Skelly Oil Co. Mr. Pearce asked the commission to fix the rate from north Texas at 70 cents per hundred on a 5.5 pounds per gallon basis or 58.5 cents per hundred on the estimated weight of 6.6 pounds per gallon. From Oklahoma the request was for a 72 cent rate at a weight of 5.5 or 60 cents at 6.6 pounds per gallon.

An important point for the manufacturers was brought out during the cross examination of J. R. Freeman of the Carter Oil Co. when the railroads sought to show that movement of natural gasoline to the east has increased in spite of the freight rates. Mr. Freeman lit a bomb shell under the attorney by his reply that the movement had increased but not by rail. He showed that the Carter Oil Co. was moving gasoline to the Standard Oil Co. of New Jersey by tank steamer to avoid the high rates.

Railroads were not prepared to put in their evidence and were granted a continuance of the case at noon Sept. 17. The date and place for the next hearing was not announced at the time of adjournment.

I.C.C. Reopens New Part of 1925 Rate Case

TULSA, Sept. 17.—The Interstate Commerce Commission has reopened for further consideration another part of the territory involved in the Mid-Continent oil rate case of 1925. No additional testimony will be taken by the commission in deciding the case, it was announced. The rate body's final decision will be based on testimony originally submitted in the case when it was tried several years ago.

The territory involved in the new reopening consists largely of the state of Missouri except St. Louis. In this area rates are now higher than they are to St. Louis as a result of the original decision, thus constituting a violation of section 4 of the Interstate Commerce Act. Special permission was given the railroads to charge the higher rates pending final decision in the case.

The order for reopening was received with satisfaction by Oklahoma refiners who made a last minute stand before the commission in order to keep Group 2 (Kansas) and Group 1 (Kansas City) refiners from obtaining reductions in rates under Oklahoma to Mississippi river crossings and points beyond. It is the view of some traffic managers in this area that the reopening indicates that the commission may not carry the Kansas differentials past the Mississippi river or at least may not make them as great as was granted originally. In order to take either of these actions it is pointed out that present rates into Missouri would have to be lowered below their present level.

New oil rates to the territory east of the Mississippi are now postponed until Nov. 20. Unless there is an additional postponement it is generally believed that the Commission's final decision may be announced shortly.

Midland Oil Men Plan Petroleum Club

HOUSTON, Sept. 15.—Oil men maintaining headquarters in the Midland district of the west Texas Permian age salt basin are organizing a petroleum club. W. A. Yeager of the Prairie Oil & Gas Co., Midland, is temporary chairman of the organization committee, working with C. C. Mason and others in developing plans for the club.

A finance committee includes George Coats of Independent Oil & Gas Co.; H. M. Bayers of Gulf Production Co.; Dave Smith of Independent Oil & Gas Co.; E. H. Stafford of Mid-Continent Petroleum Corp.; and C. C. Mason, former oil man and now a young business man of Midland. The membership committee is "Bob" Patterson of the Gulf; George Corbe of Texas Pacific Coal & Oil Co.; Forest McAdams of Llano Oil Co.; W. A. Hyatt, broker; "Dick" Knox of Atlantic Oil Producing Co.; and J. F. Hornbeck of Vacuum Oil Co.

TULSA—E. S. Porter, who has been in charge of oil sales for the Amerada Petroleum Corp., has been transferred from the New York to the Tulsa offices of the company. He is also handling the work formerly done by George Myers, assistant superintendent of production, who has resigned to engage in leasing and royalty business on his own account.

Mid-Continent Assn. Program Announced

Staff Special

TULSA, Sept. 17.—Addresses by E. W. Clark, president, American Petroleum Institute; James A. Veasey, general counsel, Carter Oil Co., and Josh Lee, humorist, University of Oklahoma, will be features of the annual banquet of the Mid-Continent Oil & Gas Association in the Mayo hotel, Tulsa, the evening of Sept. 30. Other speakers will be announced soon, said Harry H. Smith, secretary of the association. N. A. Gibson, attorney, noted throughout the southwest for his speaking ability, will be toastmaster.

At 2:30 p. m. Sept. 30 the annual business meeting will be held in the offices of the association. A new executive committee will be elected and the policy of the association on several matters will be outlined. As usual, taxation will be discussed. The perennial Campbell Russell has been circulating a petition calling for an election to vote on a larger gross production tax. He says he has enough signatures to obtain an election. His time for filing expires Sept. 24. If he files, officers of the Mid-Continent association will examine the petition and report to the members Sept. 30. It will be decided whether another campaign is to be made.

Director Don Wallace, of the petroleum safety council, a division of the Mid-Continent association, will talk briefly about the work he is directing and outline the plans for the rest of the year.

Magnolia to Build Outlet To Ranger Territory

DALLAS, Sept. 16.—Magnolia Petroleum Co., which already is laying an 8-inch pipeline from the University (Church & Fields) area of Crane county to its tank farm at Midland, on the Texas & Pacific railroad, will go ahead with construction of a 20,000-barrel outlet from the west Texas region to connection with its main transportation system in the Ranger territory.

It had been a foregone conclusion that such a line would be built, extending eastward from Midland to the Ranger territory after the manner of a similar outlet already placed in operation by the Gulf Pipeline Co.; the question about the Magnolia line was when it would be built and the size of the pipe. Confirmation is now made by the Magnolia that pipe has been ordered for an 8-inch welded line, which is expected to tie-in with the existing system at Riddle station, Comanche county, about Jan. 1, next.

Detroit Oil Man Halts Flight Around World

CLEVELAND, Sept. 19.—Edward F. Schlee, head of the Wayco Oil Corp., Detroit, and his pilot, William S. Brock, after having flown 12,295 miles of their contemplated 22,212-mile trip around the world, are returning to the United States from Tokio, Japan, by boat. They have yielded to the appeals of their families and friends, and expert aeronautical opinion in this country and Japan that an effort to fly the 2480 miles from Japan to the tiny Midway islands in the Pacific would be foolhardy.

The Detroit oil man and his pilot, who is manager of the Wayco Air Service, Detroit, another Schlee enterprise, reached Tokio Sept. 14 on the tail of a typhoon after having been held up two days by typhoons and a tidal wave that cost hundreds of lives in the vicinity of Omura, Japan, where they sought shelter on their flight from Shanghai Sept. 11.

The two men had 9,917 miles of their contemplated trip before them. They will sail from Yokohama and will reach San Francisco whence they will fly to Detroit. They are expecting to keep their plane on the deck of the Japanese liner they are returning on and to hop off for Detroit as soon as they reach the United States.

FOR SALE

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The following material, now located at Warren, Pa., will be sold immediately at a

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FOR SALE

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1—25 Ton Carbondale Absorption Refrigeration Unit

1—48"—170 Plate—Carbondale Wax Filter Press

1—36"—180 Plate—Carbondale Wax Filter Press

1—4 Cylinder Carbondale Wax Distillate Chiller—
one section wide—four sections high—
Length of cylinder exclusive of connections—
30'—10". Diameter of outside cylinder—8"

1—12 Cylinder Carbondale Wax Distillate Chiller—
two sections wide—six sections high—
Length of cylinder exclusive of connections—
19' — 5". Diameter of outside cylinder—8"

24 — 20 barrel Oil Filters

6 — 78 barrel Oil Filters

3 — 40 barrel Oil Filters

2 — 42 barrel Oil Filters

1 — 56 barrel Oil Filter

1 — 54 barrel Oil Filter

1 — 68 barrel Oil Filter

2 — 67 barrel Oil Filters

2 — 11 barrel Oil Filters

Direct all inquiries to

THE PURE OIL COMPANY

Engineering Department

35 East Wacker Drive, CHICAGO.

Compilation Of Mid-Continent Refinery Operations

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National Petroleum News

Mid-Continent Refinery Operations Week Ended September 16 (By Telegraph)

	Kansas	Oklahoma	North & Cent. Texas	North La.-Ark.	Total Week Ended Sept. 16	Total Week Ended Aug. 19
Plants Reporting	23	46	41	14	124	124
Crude Capacity (bbls.)	106,200	165,900	144,300	53,700	470,100	470,100
Cracking Capacity	29,000	45,800	15,750	20,200	110,750	110,750
Da. Av. Crude Runs	61,262 + 7.8	117,145 + 1.4	59,378 — 4.2	46,615 + 2.3	284,400 + 1.6	294,041
Da. Av. Other Oils	3,597 — 27.1	2,408 — 45.6	7,129 + 2.6	1,002 + 18.9	14,136 — 17.5	13,272
GASOLINE—Gallons						
Stocks, Sept. 9	7,412,000	36,117,000	14,955,000	2,294,000	60,478,000	70,508,000
Prod. 9-9 to 9-16	8,450,000 — 0.4	18,617,000 + 0.7	7,307,000 — 1.1	3,770,000 + 3.8	38,144,000 + 0.4	38,146,000
Ship. 9-9 to 9-16	9,695,000 — 8.0	22,493,000 + 14.2	7,057,000 — 9.5	3,892,000 + 0.9	43,137,000 + 3.0	37,921,000
Stocks, Sept. 16	5,867,000 — 17.5	32,241,000 — 10.7	15,205,000 + 1.7	2,172,000 — 5.3	55,485,000 — 8.3	70,733,000
Ratio Sales to Prod.	114.7%	120.8%	96.6%	103.2%	113.1%	99.4%
KEROSENE—Gallons						
Stocks, Sept. 9	3,648,000	4,169,000	1,921,000	419,000	10,157,000	12,209,000
Prod. 9-9 to 9-16	1,783,000 + 23.0	2,944,000 — 5.3	1,536,000 + 6.3	445,000 — 6.3	6,708,000 + 3.5	6,775,000
Ship. 9-9 to 9-16	2,067,000 + 13.7	3,402,000 + 11.9	1,824,000 + 42.8	437,000 — 16.4	7,730,000 + 16.1	7,072,000
Stocks, Sept. 16	3,364,000 — 7.8	3,711,000 — 11.0	1,633,000 — 15.0	427,000 + 1.9	9,135,000 — 10.1	11,912,000
Ratio Sales to Prod.	115.9%	115.6%	118.7%	98.2%	115.2%	104.4%
STOVE DISTILLATE—Gallons						
Stocks, Sept. 9	4,821,000	6,652,000	2,162,000	72,000	13,707,000	11,146,000
Prod. 9-9 to 9-16	437,000 — 5.4	781,000 — 1.9	236,000 — 36.2	75,000 + 5.6	1,529,000 — 10.0	1,681,000
Ship. 9-9 to 9-16	403,000 + 0.2	264,000 — 46.2	169,000 — 32.4	63,000 +152.0	899,000 — 23.0	936,000
Stocks, Sept. 16	4,855,000 + 0.7	7,169,000 + 7.8	2,229,000 + 3.1	84,000 + 16.7	14,337,000 + 4.6	11,891,000
Ratio Sales to Prod.	92.2%	33.8%	71.6%	84.0%	58.8%	55.7%
GAS OIL—Gallons						
Stocks, Sept. 9	9,681,000	40,173,000	16,758,000	10,459,000	77,071,000	72,025,000
Prod. 9-9 to 9-16	1,683,000 — 10.5	2,653,000 + 11.7	1,342,000 + 7.4	2,089,000 + 15.5	7,767,000 + 6.2	6,206,000
Ship. 9-9 to 9-16	2,350,000 + 15.8	2,635,000 +315.0	1,049,000 + 1.0	2,694,000 +127.3	8,728,000 + 78.5	4,653,000
Stocks, Sept. 16	9,014,000 — 6.9	40,191,000 + 0.04	17,051,000 + 1.7	9,854,000 — 5.8	76,110,000 — 1.2	73,578,000
Ratio Sales to Prod.	139.6%	99.3%	78.2%	129.0%	112.4%	75.0%
FUEL OIL—Gallons						
Stocks, Sept. 9	13,287,000	44,155,000	32,618,000	9,309,000	99,369,000	97,101,000
Prod. 9-9 to 9-16	6,004,000 + 4.2	7,614,000 — 2.9	7,632,000 — 4.9	7,221,000 + 5.9	28,471,000 + 0.1	30,269,000
Ship. 9-9 to 9-16	5,133,000 + 1.6	8,464,000 + 20.0	7,045,000 — 22.6	7,112,000 — 1.3	27,754,000 — 2.3	28,363,000
Stocks, Sept. 16	14,158,000 + 6.6	43,305,000 — 1.9	33,205,000 + 1.8	9,418,000 + 1.2	100,086,000 + 0.7	99,007,000
Ratio Sales to Prod.	85.5%	111.2%	92.3%	98.5%	97.5%	93.7%

Gasoline Produced by Various Methods, Week Ended September 16

	Kansas	% of Total	Oklahoma	% of Total	Texas	% of Total	Louisiana-Arkansas	% of Total	Total	% of Total
Straight Run	5,866,000	69.4	13,498,000	72.5	5,878,000	80.4	• 1,311,000	34.8	26,553,000	69.6
Cracked	2,040,000	24.2	3,467,000	18.6	1,125,000	15.4	1,898,000	50.3	8,530,000	22.4
Natural	544,000	6.4	1,652,000	8.9	304,000	4.2	561,000	14.9	3,061,000	8.0
Total	8,450,000		18,617,000		7,307,000		3,770,000		38,144,000	

+ or — columns are changes over previous week.

Mid-Continent Gasoline Stocks Cut 5,000,000 Gallons

Staff Special By Telegraph
TULSA, Sept. 20

A COMBINATION of sweltering fall weather and a resumption of export shipments gave Mid-Continent refiners another banner week in the sale of gasoline in the week ended Sept. 16. Reports gathered by NATIONAL PETROLEUM NEWS covering the operation of about 60 per cent of the operating capacity of this field show a reduction in gasoline stocks of 5,000,000 gallons to 55,485,000 gallons, or nine days' supply at current rate of shipments.

Shipments of gasoline totaled 43,137,000 gallons, a gain of more than 1,000,000 gallons over the preceding week's shipments. This is only a little below the record shipments for the year reached in the week ended Sept. 2, when jobbers were stocking for the Labor Day holiday.

Gasoline shipments in the past three

Summary for the Month

Production and shipments, all reporting refineries, for four weeks ended Sept. 16. Change in stocks figures from Aug. 19.

GASOLINE

	Gallons
Production	152,207,000
Shipments	167,455,000
Net changes in stocks	— 15,248,000
Ratio sales to production	110.0%

KEROSENE

	Gallons
Production	25,292,000
Shipments	28,069,000
Net change in stocks	— 2,777,000
Ratio of sales to production	111.0%

STOVE DISTILLATE

	Gallons
Production	6,556,000
Shipments	4,110,000
Net change in stocks	+ 2,446,000
Ratio sales to production	62.7%

GAS OIL

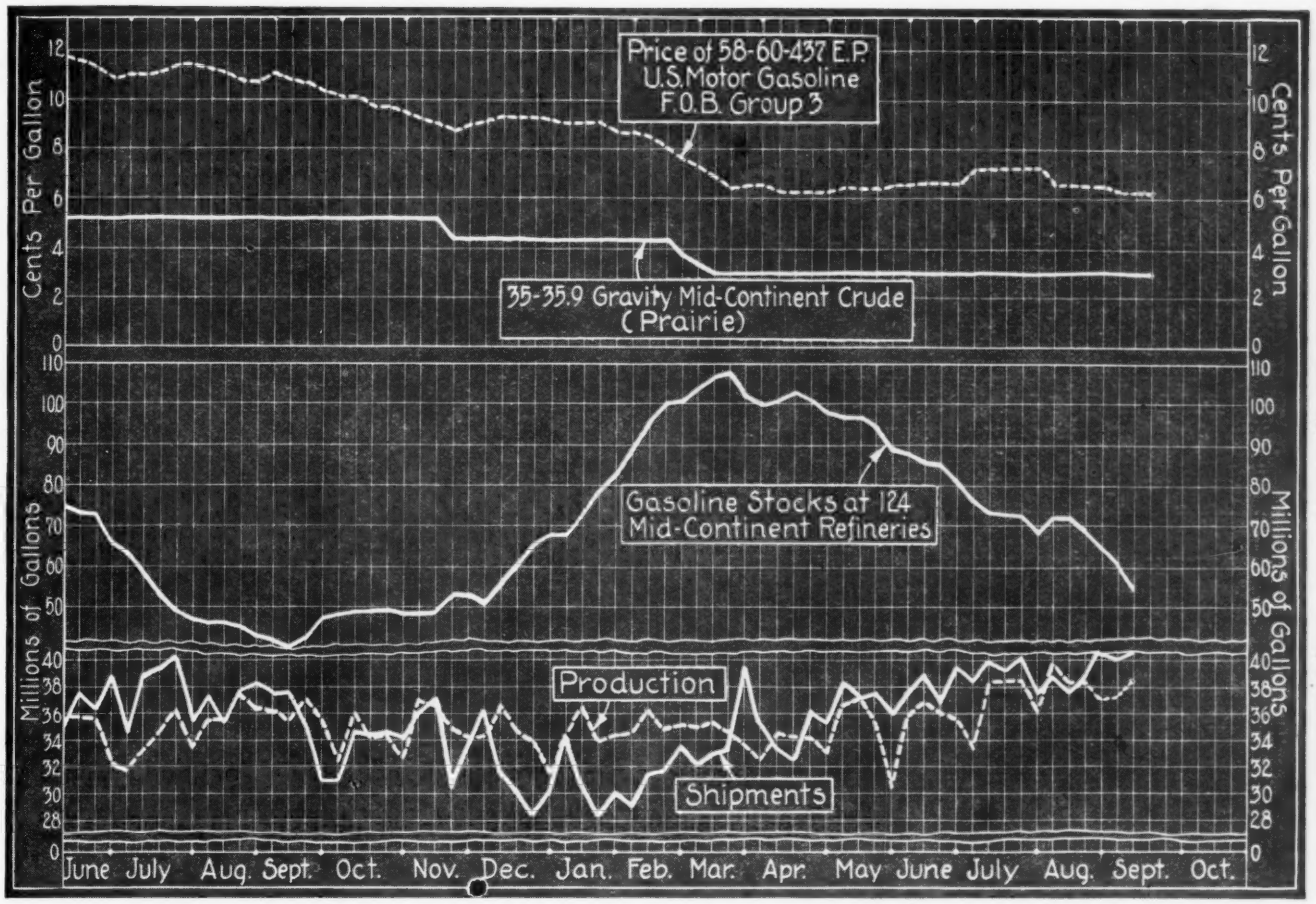
	Gallons
Production	29,525,000
Shipments	26,993,000
Net change in stocks	+ 2,532,000
Ratio sales to production	91.4%

FUEL OIL

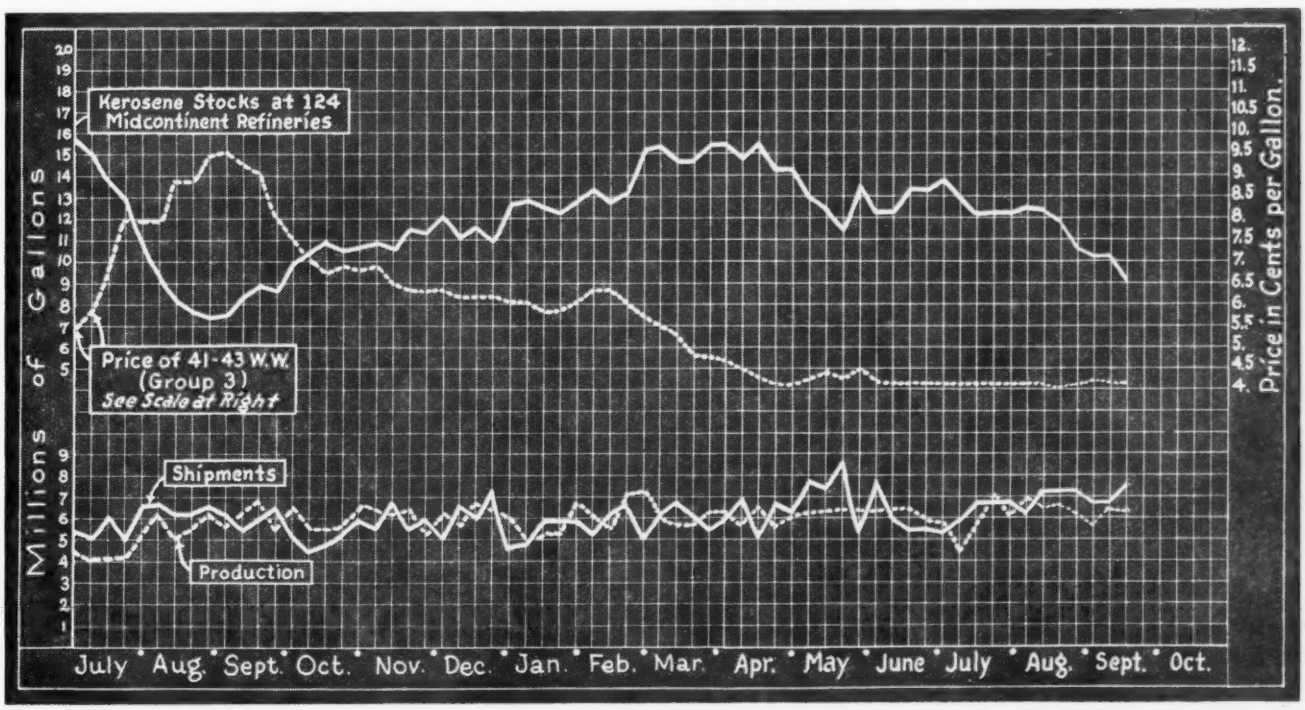
	Gallons
Production	113,465,000
Shipments	112,386,000
Net change in stocks	— 1,079,000
Ratio sales to production	99.0%

Barometer of Mid-Continent Refinery Market—Week Ending September 16

Charted Course of Prices, Production, Shipments, Stocks of Principal Refined Products, Week by Week, From Reports Made by 124 Plants to National Petroleum News

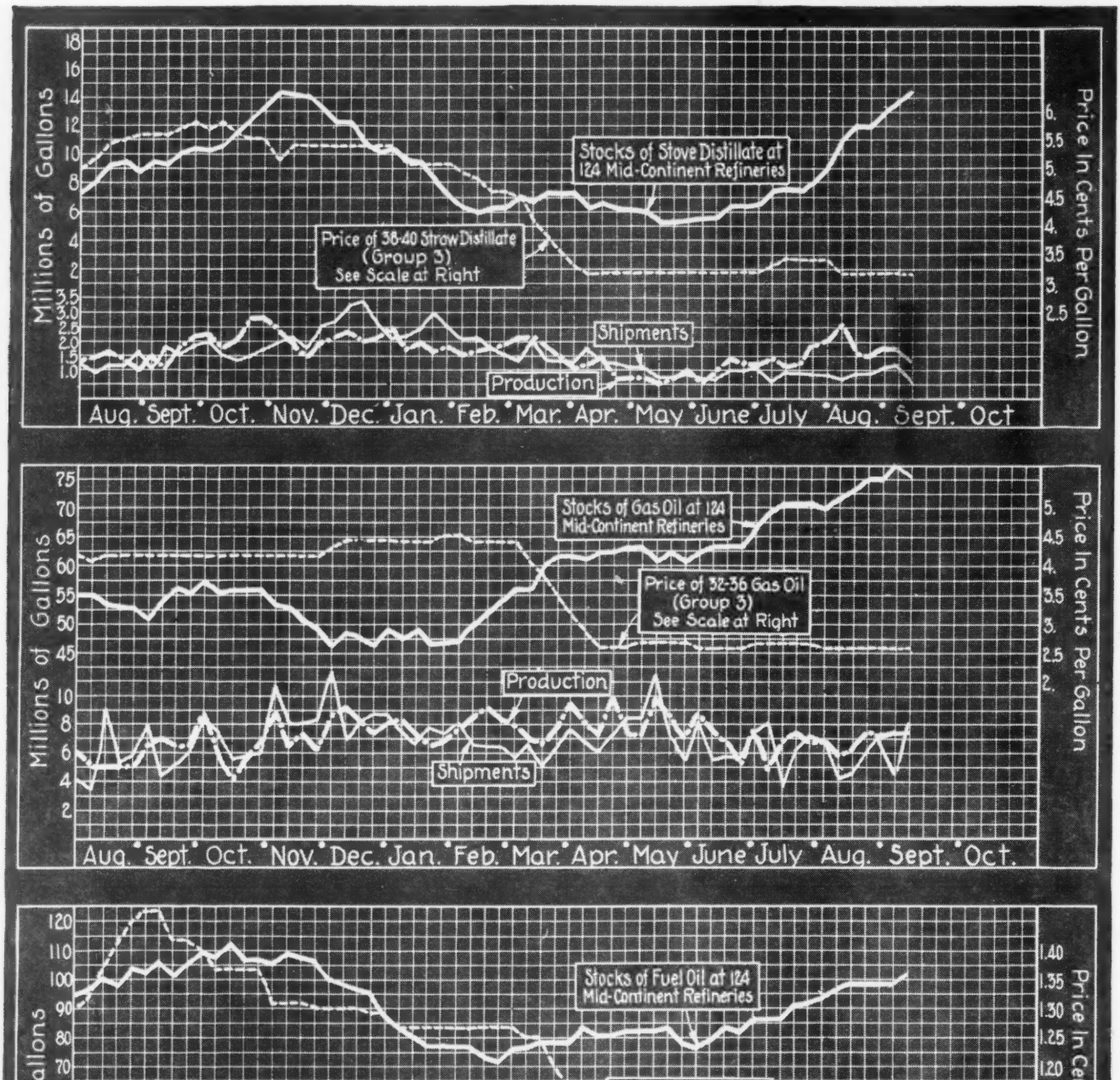

Price of 58-60-437 E.P. U.S. Motor Gasoline F.O.B. Group 3
35-35.9 Gravity Mid-Continent Crude (Prairie)
Cents Per Gallon
Gasoline Stocks at 124 Mid-Continent Refineries
Production
Shipments
Millions of Gallons
June July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct.

***Prices** shown above are extended to date shown in Refinery Market and Crude tables in Market section of this issue and stocks, shipments and Production are extended to date shown in table on opposite page*


Kerosene Stocks at 124 Midcontinent Refineries
Price of 41-43 W.W. (Group 3) See Scale at Right
Shipments
Production
Millions of Gallons
Price in Cents per Gallon.
July Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct.

Barometer of the Mid-Continent Refinery Market—Week Ending Sept. 16, 1927

Charted Course of Prices, Production, Shipments, Stocks of Principal Refined Products, Week by Week, From Reports Made by 124 Plants to National Petroleum News

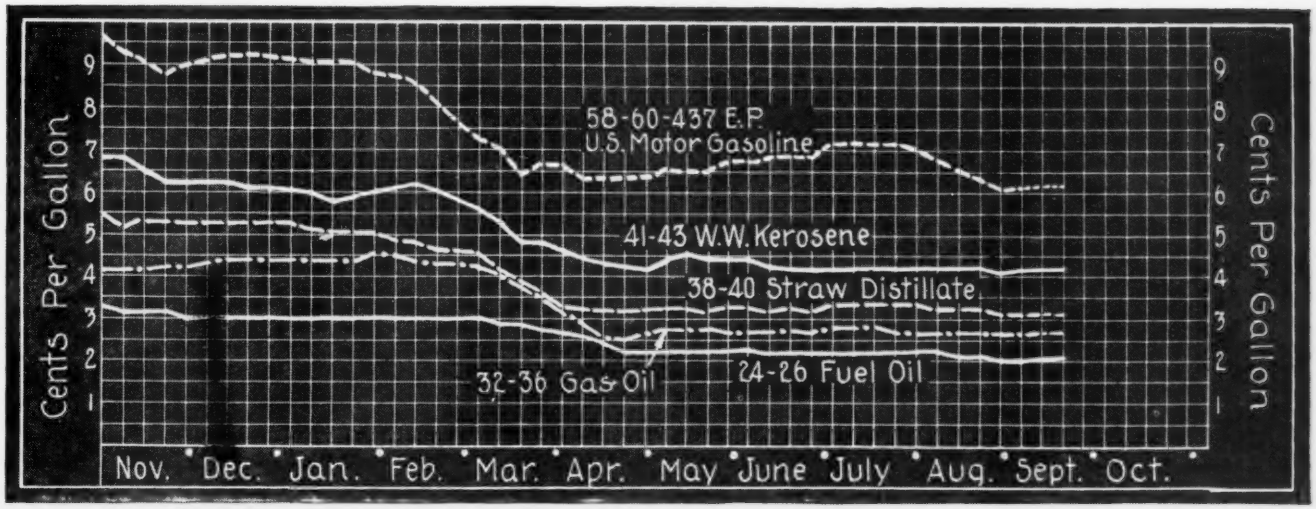

Millions of Gallons
Price In Cents Per Gallon
Stocks of Stove Distillate at 124 Mid-Continent Refineries
Price of 38-40 Straw Distillate (Group 3) See Scale at Right
Shipments
Production
Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct
Millions of Gallons
Price In Cents Per Gallon
Stocks of Gas Oil at 124 Mid-Continent Refineries
Price of 32-36 Gas Oil (Group 3) See Scale at Right
Production
Shipments
Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct.
Millions of Gallons
Price In Cents Per Gallon
Stocks of Fuel Oil at 124 Mid-Continent Refineries
Price of 24-26 Fuel Oil (Group 3) See Scale at Right
Shipments
Production
Aug. Sept. Oct. Nov. Dec. Jan. Feb. Mar. Apr. May June July Aug. Sept. Oct.

weeks have been at a higher level than any previous period this year. Stocks of gasoline were reduced 15,248,000 gallons in the four weeks ended Sept. 16 because crude runs have been kept well below the summer level.

Crude runs for the current week averaged 284,400 barrels a day. Runs averaged 4,875 barrels daily more than in the previous week but were a little more than 1,000 barrels less than the average daily runs in the week ended Sept. 2.

Oklahoma and Kansas refiners enjoyed a heavier run of gasoline business last week than their competitors in Arkansas, north Louisiana and Texas. Kansas refiners cut their gasoline stocks 1,250.000 gallons to a low point of 5,867,000 gallons or less than five days' supply at the current rate of shipment. Oklahoma refiners cut their stocks nearly 3,900,-

Current Prices of Principal Mid-Continent Refined Products



Prices shown above are on Group 3 basis and extended to date shown in Refinery Market Tables in Market Section of this Issue

000 gallons when their shipments reached a new high total for a single week of 22,493,000 gallons. Arkansas gasoline stocks now are down to about four days' supply, about a working stock. Texas refiners reported an increase in stocks of 25,000 gallons.

Shipments of kerosene increased more than 1,000,000 gallons to 7,730,000 gallons while production was increased only 320,000 gallons to 6,708,000 gallons. Stocks were cut 1,020,000 gallons to 9,135,000 gallons, the lowest point reached since September, 1926.

Stocks of distillate continued to increase. Shipments of this commodity fell to 899,000 gallons, a decline of 23 per cent. Stocks increased 600,000 gallons or 4.6 per cent to 14,337,000 gallons. A year ago distillate stocks totaled approximately 10,000,000 gallons.

Gas oil shipments were on a much more satisfactory level than at any time since middle July. Stocks were reduced 1,000,000 gallons to 76,110,000 gallons.

Shipments of fuel oil were slightly less. Production was almost unchanged. Stocks at all reporting plants increased 720,000 gallons or 0.7 per cent to 100,086,000 gallons.

Eastern Jobber to Erect Stations

IRVINGTON, N. J.—Hellmund Refining Corp., with headquarters here, is now erecting a bulk station here with 300,000 gallons capacity. The station has a siding on the Lehigh Valley Railroad.

The company is also building a filling station at Maplewood, N. J., and has just completed one at Irvington. It has eight sites for filling stations, according to H. E. Hellmund, manager. It also has railroad siding at Newark, N. J.

The company buys in the spot market.

California Settled Production Shows Tendency to Decline

Staff Special

LOS ANGELES, Sept. 17

CALIFORNIA fields the past week showed a tendency towards small declines in settled production; with indications that Seal Beach has about reached its new peak, with the sharp decline only a few days off.

Several splendid wells have been completed in the Alamitos Heights area of the Seal Beach field the past week, but they do not hold up well. For instance Marland Oil company completed Selover 13 for slightly better than 5000 barrels in the Wasem sand, at a total depth of about 5700 feet, but within five days this well was making about 4000 barrels. Marland also completed Selover 14 for about 3500 barrels at about the same depth. Five other wells were completed with flush production of more than 1000 barrels per well.

Several of the wells drilling deeper for the Wasem sand have penetrated gray sand at about 5600 feet, and have had to plug back, thus delaying completions, but proving up the depth of the sand. With approximately 20,000 barrels of new production last week, the field showed an increase of about 3000 barrels, indicating a decline of some 17,000 barrels per day in the producing wells. But a portion of this decline is represented by producers shut down to drill deeper into the sand, for a greater production. Authorities estimate the Seal Beach daily production at the end of December at 35,000 to 50,000 barrels, although the writer leans to the opinion that about 35,000 barrels is the best estimate.

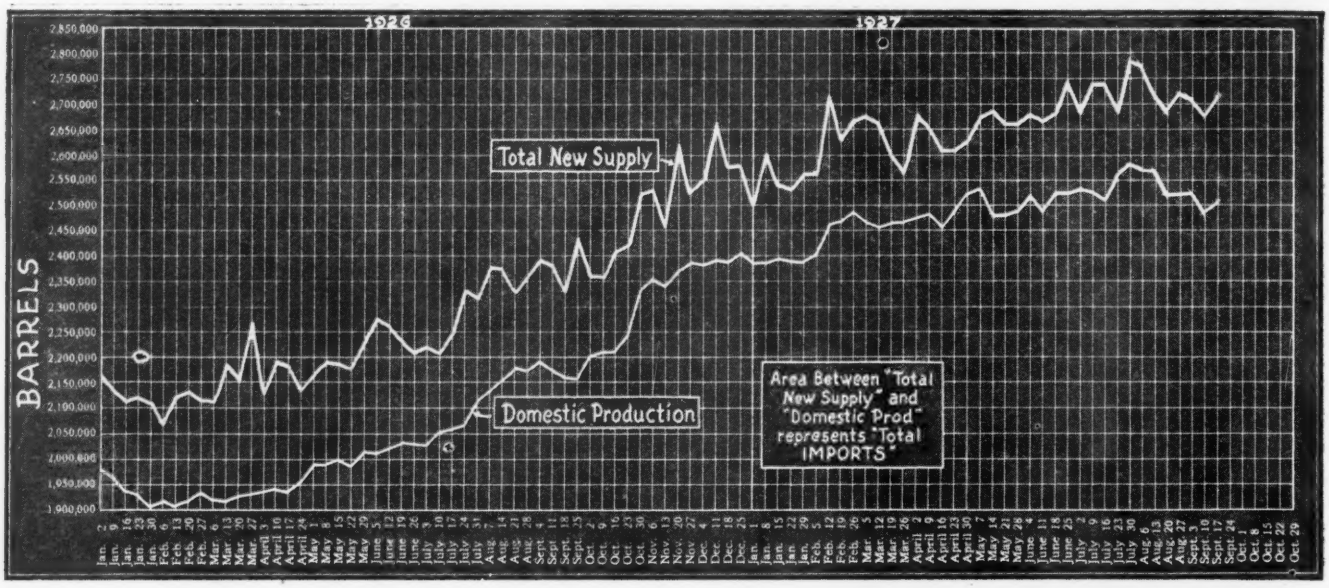
At Ventura Avenue, 30 wells are drilling, and this field will do well to hold close to its present production unless several of the wells are completed for larger initial productions than expected by some authorities.

Interest continues in the Pacific Eastern well at Bakersfield, which has been testing for several weeks. During the past week, the hole was bailed down carefully with a plug at the bottom in an attempt to control the heaving sand, which has prevented the well from flowing. Late in the week the hole was being swabbed. For a time the gas pressure was lost, but late in the week it gave evidence of being restored as the bailing progressed.

Associated's Cypress wildcat, about midway between Rosecrans and Inglewood, just outside Los Angeles city limits, was on a production test during the week, and it refused to flow, although it has a good gas pressure, flowing gas with a natural gasoline content of 2 gallons to the 1000 cubic feet, and making some oil around 36 gravity. Decision was reached late in the week to drill deeper, for another production test.

The C. C. M. O. wells in the Rincon area west of Ventura avenue are drilling deeper, with indications very good. Considerable real oil sand has been penetrated in both wells, with a heavy gas pressure.

Daily Average Crude Oil Production and Imports



Daily average gross output of United States, by fields, for week ending with dates below as compiled by American Petroleum Institute

PRODUCTION SUMMARY

	Sept. 17	Sept. 10
Production east of Rockies	1,855,750	*1,866,000
Decrease		10,250
Total production in U. S.	2,494,850	*2,505,400
Decrease		10,550
Crude oil imports	220,143	185,857
Increase		34,286
Total crude supply	2,714,993	*2,691,257
Increase		23,736

*Revised.

OKLAHOMA

	Sept. 17	Sept. 10
North Braman	3,050	3,050
South Braman	2,200	2,300
Blackwell	3,950	4,000
Hubbard	4,100	4,400
Thomas	4,200	4,150
Tonkawa	18,700	19,000
Barber	10,950	11,100
Burbank	36,150	36,450
Osage, outside Burbank	31,050	31,200
Watchorn	1,800	1,800
Cushing	21,250	21,200
Yale Jennings	9,700	9,800
Davenport	2,800	2,800
Bristow-Slick	25,050	25,100
North Okmulgee	16,250	16,300
Lyons-Deaner	5,050	5,100
Stroud	1,250	1,250
Cromwell	12,950	12,150
Papoose	6,500	6,400
Wewoka	13,650	13,850
Seminole	264,750	272,200
Earlsboro	161,700	164,950
Duncan district	7,000	6,950
Graham	6,750	6,750
Fox	1,900	1,900
Healdton	15,000	15,000
Hewitt	9,650	9,600
Scholem Alechem	16,450	*16,350
Others	68,600	*68,200
Total Oklahoma	782,400	*793,600
Decrease		11,200

*Revised.

KANSAS

	Sept. 17	Sept. 10
Greenwood County	33,250	33,450
Florence-Covert	1,600	1,600
Peabody-Elbing	3,850	3,900
Eldorado-Towanda	14,100	14,050
Augusta-Fox-Bush	4,300	4,250
Rainbow Bend	2,200	2,200
Russell	2,500	2,500
Churchill	13,750	14,100
Others	29,700	29,500
Total, Kansas	105,250	105,550
Decrease		300

NORTH LOUISIANA

	Sept. 17	Sept. 10
Homer	4,700	4,700
Haynesville	7,050	7,100
Caddo, light	13,700	14,950
Caddo, heavy	5,100	5,350
De Soto, Red River	4,000	4,100
Elm Grove	650	700
Bellevue	1,150	1,250
Cotton Valley	5,350	5,350
Urania	10,150	10,200
Pleasant Hill	1,550	650
Total, N. Louisiana	53,400	54,350
Decrease		950

ARKANSAS

	Sept. 17	Sept. 10
El Dorado	5,950	5,650
Smackover, light	10,100	10,300
Smackover, heavy	78,450	78,800
Stephens	1,200	1,200
Nevada	2,700	2,550
Lisbon	3,000	3,200
Others	100	100
Total, Arkansas	101,500	101,800
Decrease		300

TEXAS (OUTSIDE GULF COAST)

Panhandle District

	Sept. 17	Sept. 10
Hutchinson County	77,650	78,000
Carson County	8,850	9,300
Gray County	9,750	9,750
Wheeler County	1,450	1,400
Others	50	50
Total, Panhandle District	97,750	98,500
Decrease		750

North Texas

	Sept. 17	Sept. 10
Burkburnett	12,950	13,000
Electra	12,100	12,250
Iowa Park and K-M-A	2,200	2,300
Wilbarger	12,000	12,200
Archer County	26,400	26,550
Montague-Cooke	15,900	16,050
Others	700	700
Total, North Texas	82,250	83,050
Decrease		800

West Central Texas

	Sept. 17	Sept. 10
Stephens County	8,400	8,300
Eastland-Desdemona	9,250	9,000
Brown County	24,400	24,650
Coleman County	1,200	1,200
Callahan County	3,750	3,900
Shackleford County	5,900	6,000
Young County	10,700	10,950
Throckmorton County	1,250	1,350
Palo Pinto County	800	800
Others	1,350	1,350
Total, West Central		
Texas	67,000	67,500
Decrease		500

West Texas

	Sept. 17	Sept. 10
Jones County	1,950	1,800
Mitchell and Scurry Counties	3,800	3,750
Howard County	3,150	3,350
Reagan County	24,100	24,850
Crane and Upton Counties	128,300	128,300
Crockett County	2,050	1,350
Pecos County	7,650	6,150
Winkler County	4,700	4,850
Others	2,500	2,000
Total, West Texas	178,200	176,400
Increase		1,800

East Central Texas

	Sept. 17	Sept. 10
Mexia	9,500	9,650
Currie	650	650
Richland	750	800
Wortham	2,900	2,650
Corsicana-Powell	15,000	14,650
Nigger Creek	1,750	2,000
Total, East Central Texas	30,550	30,400
Increase		150

Southwest Texas

	Sept. 17	Sept. 10
Luling	16,000	16,300
Lytton Springs	1,600	1,750
Somerset	900	900
Laredo District	9,600	9,750
Piedras Pintas	50	50
Others	600	500
Total, Southwest Texas	28,750	29,250
Decrease		500
Total, Texas (Outside Gulf Coast)	484,500	485,100
Decrease		600

GULF COAST

Coastal Texas

	Sept. 17	Sept. 10
West Columbia	8,550	8,850
Damon Mound	900	900
Big Creek	2,500	2,550
Boling	2,700	1,400
Blue Ridge	3,750	3,300
Pierce Junction	8,450	6,950
Humble	2,300	2,350
Goose Creek	8,250	8,350
South Liberty	2,750	2,800
Hull	14,200	14,400
Saratoga	900	1,000
Batson	1,550	1,300
Sour Lake	4,100	4,150
Spindletop	59,000	56,300
Orange County	4,850	4,700
Others	4,000	4,150
Total, Coastal Texas	128,750	123,450
Increase		5,300

Coastal Louisiana

	Sept. 17	Sept. 10
Vinton	4,950	5,050
Lockport	6,000	6,250
Evangeline	1,200	1,200
Edgerly	2,450	2,350
Others	1,800	1,950
Total, Coastal Louisiana	16,400	16,800
Decrease		400
Total, Gulf Coast	145,150	140,250
Increase		4,900

ROCKY MOUNTAIN

Wyoming

	Sept. 17	Sept. 10
Salt Creek	32,850	33,400
Grass Creek	2,650	2,550
Elk Basin	1,000	1,000
Big Muddy	3,000	2,800
Lost Soldier	2,850	2,800
Rock River	2,750	2,200
Lance Creek	650	650
Teapot Dome	750	550
Others	3,550	4,500
Total, Wyoming	50,050	50,450
Decrease		400

Montana

	Sept. 17	Sept. 10
Cat Creek	2,100	2,100
Sunburst	11,500	10,000
Others	200	250
Total, Montana	13,800	12,350
Increase		1,450

Colorado

	Sept. 17	Sept. 10
Moffat (Craig)	1,650	1,550
Fort Collins	2,750	3,950
Florence	950	900
Others	1,300	1,500
Total, Colorado	6,650	7,900
Decrease		1,250

New Mexico

	Sept. 17	Sept. 10
Table Mesa	250	250
Artesia	1,300	1,450
Hogback	700	650
Rattlesnake	300	300
Total, New Mexico	2,550	2,650
Decrease		100
Total, Rocky Mountain	73,050	73,350
Decrease		300

CALIFORNIA

	Sept. 17	Sept. 10
Santa Fe Springs	39,000	40,500
Long Beach	91,000	91,000
Huntington Beach	67,000	68,000
Torrance	21,500	21,500
Dominguez	15,000	15,000
Rosecrans	8,000	8,000
Inglewood	33,000	33,500
Midway-Sunset	84,000	84,000
Ventura Avenue	58,100	57,900
Seal Beach	67,500	65,000
Others	155,000	155,000
Total, California	639,100	639,400
Decrease		300

EASTERN

	Sept. 17	Sept. 10
(Including Ill., Ind., Ky., Ohio, W. Va., Pa., and N. Y.)	110,500	112,000
Decrease		1,500

Refinery - Tank Wagon Markets

National Petroleum News

Favorable Weather Helps Light Oil Demand in Mid-Continent

Staff Special
TULSA, Sept. 17

LIGHT oils were again active this week in every area of the Mid-Continent refinery district. Favorable weather for both gasoline and kerosene consumption prevailed in most of the consuming territory. Heavy oils while not in active demand nevertheless were moving in sufficient volume to prevent any price recessions, in view of the fact their season is just around the corner.

Several Oklahoma refiners who had been accepting some business at 6 cents on 58-60 U. S. Motor gasoline late in the week moved their prices to 6.125 cents bottom, while others kept their prices firmly at 6.25 cents. Marketers today reported that only in a few instances could they get any 58-60 U. S. Motor at 6 cents in this field.

The advance in crude prices by Magnolia Petroleum Co. brought some optimism to North Texas refiners and in view of the fact that only two or three now are making 58-60 U. S. Motor gasoline prices on this grade moved up slightly late in the week.

One export company bought about 200,000 gallons of 64-66, 375 e. p. gasoline early in the week at 6.375 cents a gallon, f. o. b. north Texas refinery. Two export representatives late in the week, however, were inquiring for some more goods at that price and apparently had been unable to find any sellers. The prevailing quotations on the 64-66 grade for export was 6.50 to 6.625 cents. The north Texas refiners operating now say they have sufficient volume of orders on their books for another 10 days or two weeks.

Domestic demand for higher gravities has been felt both in Oklahoma and Texas, and several refiners have advanced their quotations from an eighth to a quarter of a cent. The demand for this grade of goods is expected to show a steady increase from now on as jobbers gradually work off their lower gravity goods and replace their tanks with goods suitable for winter driving requirements

Kerosenes have become strong and comparatively scarce in the entire field within the past few days. The Standard Oil Co. of Louisiana has bought 41-43 kerosene from Oklahoma and Louisiana plants, the goods to be used on their domestic orders in the southeast. The company was reported to be shipping some of its own kerosene on export orders, and filling out on domestic orders with purchases on the outside.

Kerosene stocks in the field are at their lowest level of the year, although they are not as low as for the same period last year. Several large Oklahoma refiners are reported to have only small stocks of kerosene and most of this will be used through their own stations. The favorable weather has given farmers an opportunity to get into the fields recently and do some of their fall plowing, the domestic demand for kerosene picking up accordingly.

THERE have been several export sales the past two or three weeks by north Texas refiners. These purchases coupled with a better domestic demand has taken a large quantity of goods which had been held in storage, together with practically all the current production. Prices on 41-43 w. w. kerosene in north Texas today were almost as strong as in Group 3.

A few inquiries for kerosenes for over October have been received in the field. One company has quoted 4.50 cents a gallon on two inquiries for 41-43 w. w. grade and indications are other quotations have been made about in line with these two.

Only a few plants in Oklahoma make 42-44 w. w. kerosene and the goods are extremely scarce. One refiner who has been making this grade closed his refinery this week, with the announcement that the plant would remain closed until conditions became more favorable in the refining industry.

While the natural gasoline market was tending downward most of the month considerable buying was being done, some of it entirely new orders. As a result two or three companies found themselves short on goods after the middle of the month and began actively to inquire for gasolines to cover on the sales they had made. This activity became apparent late this week and prices accordingly moved up an eighth of a cent today.

Some of the buying has been done by large refiners while other orders have been for export. Demand for goods to move to eastern points has been good, and since Texas has a more advantageous freight rate than Oklahoma, buyers have been paying slightly more for Texas goods.

Distillates have been the slowest commodity as far as movement is concerned, although in view of the season just ahead prices have shown no changes. One large Oklahoma refiner said today that the only product he is running to storage now is distillates. The demand naturally could not be good, however, with the present warm weather throughout the country.

The first cold spell is not expected to stimulate distillate sales to any large extent. Many large jobbers are known already to have filled their distillate tanks, after making summer fills for customers. The customers will have to use up their fills before the jobbers can start to draw on their stocks, and it probably will take at least two cold spells before an active market is developed in this territory.

The representative of one large jobber said this week that the cool weather in August started their customers to calling for distillates. They accordingly bought heavily and filled the tanks, only to have the hot weather cut in again just about the time they had gotten their tanks full.

GAS oil prices are unchanged with demand about normal. Exporters have been active in Texas recently, and with the cotton ginning season on now, goods are relatively scarce. This scarcity has reflected indirectly on Oklahoma, since buyers who cannot get gas oil for less than 2.50 cents north Texas, are more than willing to pay that price, Group 3, since to many northern points the freight differential is in favor of Oklahoma.

North Louisiana refiners are making contracts on their gas oil for this winter. Their goods are in de-

(*Continued on Page* 357)

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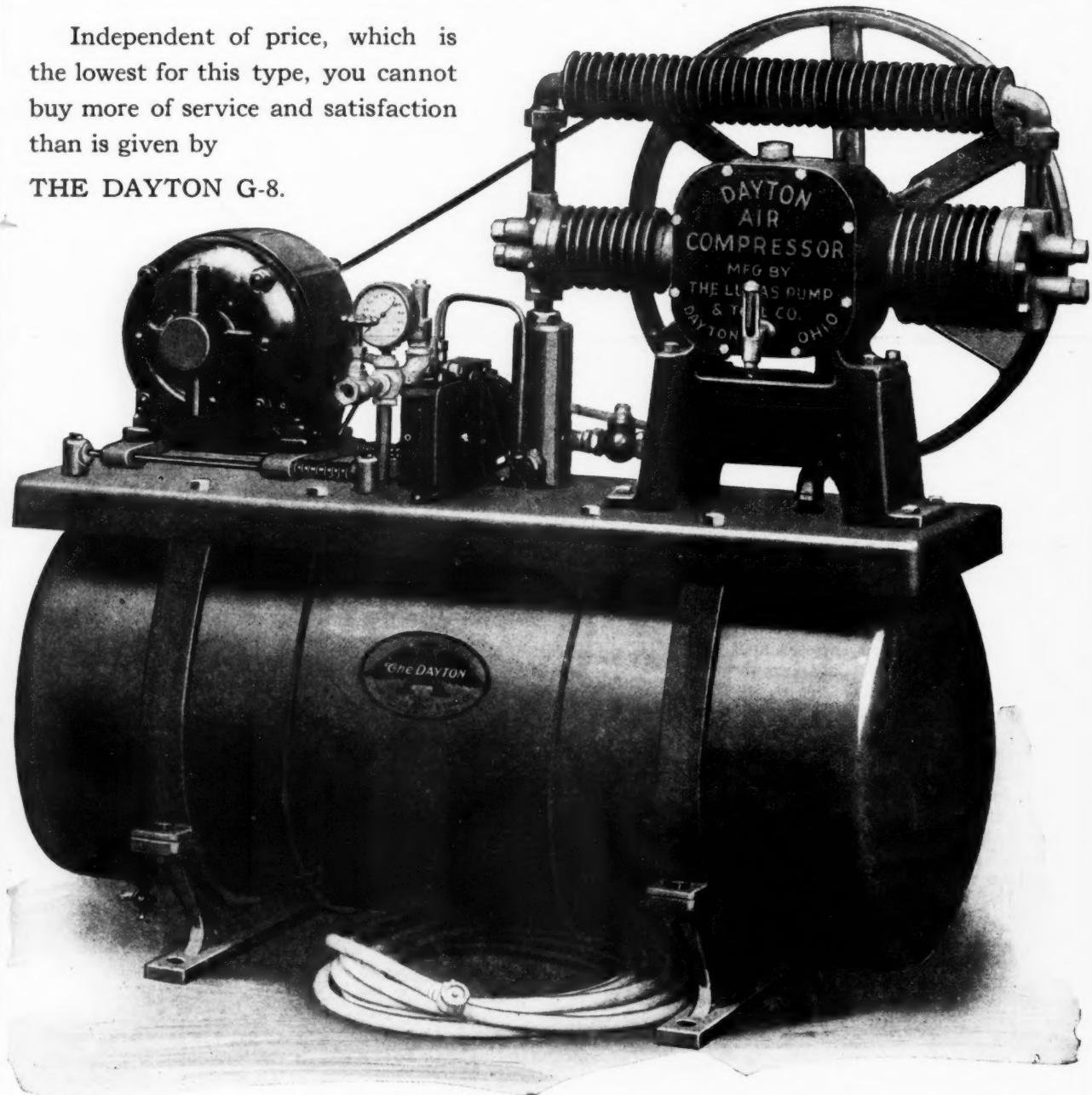

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Refinery Markets on Light Oils and Lubricants

Prices given below are in cents per gallon, F. O. B. refinery, except where $ is shown

(These Refinery Prices compiled in the OIL PRICE HANDBOOK for a whole year)

GASOLINE AND NAPHTHA

	Prices Sept. 19	Prices Sept. 12	Prices Sept. 6
PENNSYLVANIA			
52-54 Naphtha	8.25 – 8.50	8.25 – 8.50	8.25 – 8.50
54-56 Naphtha	8.25 – 8.625	8.50 – 8.625	8.25 – 8.75
58-60 Gasoline	8.00 – 8.50	8.25 – 8.50	8.25 – 8.50
60-62 Str.-run gasoline	8.75 – 9.25	8.75 – 9.25	8.75 – 9.25
64-66 Str.-run gasoline	9.50 –10.00	9.50 –10.00	9.50 –10.25
68-70 Str-run gas. 350-360 e.p.	10.00 –10.50	10.00 –10.50	10.25 –10.75
OKLAHOMA			
48-50 450 e.p. naphtha	6.00	6.00	6.00
50-52 450 e.p. naphtha	6.00	6.00	6.00
56-58 450 e.p. gasoline	6.00	6.00	5.75 – 6.25
58-60 450 e.p. gasoline	6.00	6.00	5.875– 6.25
56-58 U. S. Motor, 437 e.p.	*6.00 – 6.125	*6.00	*6.00 – 6.25
58-60 U. S. Motor, 437 e.p.	6.125– 6.25	6.00 – 6.25	6.00 – 6.375
60-62 437 e.p. gasoline	**6.25 – 6.75	**6.125– 6.75	6.125– 6.75
60-62 400 e.p. gasoline	**6.50 – 7.00	**6.25 – 7.00	**6.50 – 7.00
64-66 390 e.p. gasoline	**6.50 – 7.00	**6.50 – 7.00	**6.50 – 7.00
64-66 375 e.p. gasoline	**6.75 – 7.25	**6.75 – 7.25	**6.75 – 7.25
68-70 350-360 e.p. gasoline	**7.00 – 7.50	**7.00 – 7.50	**7.00 – 7.50
KANSAS* (F. O. B. refinery Kansas destination)			
58-60 U. S. Motor 437 e.p.	6.375– 6.50	6.25 – 6.375	6.25 – 6.50
60-62 400 e.p. gasoline	6.75 – 7.00	6.75 – 7.00	6.75 – 7.00
64-66 375 e.p. gasoline	7.25	7.25	7.25
NORTH TEXAS			
48-52 450 e.p. naphtha	†6.00	†6.00	†6.00
56-58 450 e.p. gasoline	5.75	5.75	5.75
58-60 450 e.p. gasoline	5.75	5.75	5.75
58-60 U. S. Motor 437 e.p.	6.125	6.00	6.00
60-62 400 e.p. gasoline	6.375	6.25	6.25
64-66 390 e.p. gasoline	6.375– 6.50	6.375	6.375
64-66 375 e.p. gasoline	6.50 – 6.75	6.50 – 6.625	6.375– 6.625
68-70 350-360 e.p. gasoline	*7.00 – 7.25	*7.00 – 7.25	*7.00 – 7.25
NORTH LOUISIANA (For Louisiana and differential territory destination)			
58-60 U. S. Motor gasoline	6.375– 6.50	6.25 – 6.50	6.25 – 6.50
ARKANSAS (For Arkansas intrastate shipment)			
56-58 450 e.p. gasoline	6.25	6.25	6.25
58-60 450 e.p. gasoline	6.25	6.25	6.25
58-60 U. S. Motor 437 e.p.	6.25 – 6.50	6.25 – 6.50	6.50
ARKANSAS (F. O. B. Arkansas refineries for interstate shipment)			
58-60 U. S. Motor 437 e.p.	**6.00 – 6.50	**6.00 – 6.50	**6.25 – 6.50
CALIFORNIA			
*54-58 U.S. Motor 437 e.p.	7.25 – 8.50	7.25 – 8.50	7.25 – 8.50
*58-61 U.S. Motor 437 e.p.	8.50 – 9.50	8.50 – 9.50	8.50 – 9.50
*42-45 Eng. dis. 445-480 e.p.	6.50 – 7.00	6.50 – 7.00	6.50 – 7.00

*2c tax to be added if used in state.

NEW ENGLAND

"These prices have been discontinued in this table and will appear hereafter in the Seaboard market for Boston."

NATURAL GASOLINE

(Note: End point of all grades, not over 375° F.)

OKLAHOMA			
Grade AA, 80-87.9, 90% Recovery	6.00 – 6.25	5.50 – 5.875	5.75 – 6.00
Grade A, 72-79.9, 90% Recovery	6.00 – 6.25	5.50 – 5.875	5.75 – 6.00
Grade BB, 84-92, 85% Recovery	5.625– 5.75	5.25 – 5.375	5.375– 5.50
Grade B, 76-83.9, 85% Recovery	5.625– 5.75	5.25 – 5.375	5.375– 5.50
Grade C, 80-90, 78% Recovery	5.625	5.00 – 5.25	5.125– 5.375
NORTH TEXAS (F. O. B. Breckenridge)			
Grade AA, 80-87.9, 90% Recovery	6.00 – 6.25	5.625– 5.75	5.75 – 6.00
Grade A, 72-79.9, 90% Recovery	6.00 – 6.25	5.625– 5.75	5.75 – 6.00
Grade BB, 84-92, 85% Recovery	5.625– 5.75	5.25 – 5.375	5.375– 5.50
Grade B, 76-83.9, 85% Recovery	5.625– 5.75	5.25 – 5.375	5.375– 5.50
Grade C, 80-90, 78% Recovery	5.625	5.00 – 5.25	5.125– 5.375
NORTH LOUISIANA (F. O. B. Monroe District)			
Grade AA	†6.25	†6.25	†6.25
Grade BB	†6.00	†6.00	†6.00
Grade C	†6.00	†6.00	†6.00
CALIFORNIA			
75-85, 375-390 e.p. blend	8.00 –10.00	8.00 –10.00	8.00 –10.00

MOTOR FUEL BLENDS

PENNSYLVANIA			
68-70 Blend 437 e.p.	Prices	.....	.....
64-66 Blend 437 e.p.	Temporarily	.....	.....
60-62 Blend 437 e.p.	discontinued	.....	.....
OKLAHOMA			
64-66 Blend 437 e.p.	5.75 – 5.875	5.75 – 6.00	5.875– 6.25

BURNING OILS

PENNSYLVANIA			
45 w.w. kerosene	6.125– 6.25	6.00 – 6.25	5.875– 6.00
46 w.w. kerosene	6.50 – 6.625	6.50	6.00 – 6.50
47 w.w. kerosene	7.00 – 7.25	7.00	6.50 – 7.00
OKLAHOMA			
41-43 w.w. kerosene	4.25 – 4.375	4.125– 4.25	4.125– 4.25
42-44 w.w. kerosene	4.75	4.625– 4.75	4.50
KANSAS (F. O. B. refinery Kansas destination)			
41-43 w.w. kerosene	4.75 – 5.25	4.75 – 5.25	4.75 – 5.25
42-44 w.w. kerosene	5.50 – 5.75	5.50 – 5.75	5.50 – 5.75
NORTH TEXAS			
40-42 w.w. kerosene	†4.00	3.75	3.75
41-43 w.w. kerosene	4.125– 4.25	4.00 – 4.125	4.00
NORTH LOUISIANA (For Louisiana and differential territory destination)			
41-43 w.w. kerosene	4.50	4.25 – 4.50	4.25 – 4.50
ARKANSAS (For intrastate shipment only)			
1-43 kerosene	.....	.....	4.25
2-44 kerosene	4.75	4.50 – 4.75	4.50 – 4.75
ARKANSAS (F. O. B. Arkansas refineries for interstate shipment)			
1-43 kerosene	.....	.....	4.125– 4.25
2-44 kerosene	4.50 – 4.75	4.50	4.50
CALIFORNIA			
8-40 w.w. kerosene	5.00 – 5.50	5.00 – 5.50	5.00 – 5.50

NEW ENGLAND

"These prices have been discontinued in this table and will appear hereafter in the Seaboard market for Boston."

NEUTRAL OIL

Vis.			
PENNSYLVANIA	**(Viscosity at 70°F.)**		
200 No. 3 Assoc. Filt.	34.50 –35.50	34.50 –35.50	34.50 –35.50
180 No. 3 Assoc. Filt.	31.75 –32.50	31.75 –32.50	31.75 –32.50
150 No. 3 Assoc. Filt.	27.75 –28.50	27.75 –28.50	27.75 –28.50
	(Non Viscous)		
34 Grav. 330-340 Flash	7.00 – 7.50	7.00 – 7.50	7.00 – 7.50
36 Min. Neut. 300-305 Flash	6.50 – 7.00	6.50 – 7.00	6.50 – 7.00
****OKLAHOMA**			
Vis. Color	**(Viscosity at 100°F.)**		
100—No. 2	6.00 – 6.50	6.00 – 6.50	6.00 – 6.50
150—No. 3	8.25 – 8.50	8.25 – 8.50	8.25 – 8.50
150—No. 4	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
180—No. 3	9.50 –10.00	9.50 –10.00	9.50 –10.00
180—No. 4	9.50 – 9.75	9.50 – 9.75	9.50 – 9.75
180—No. 5	9.25 – 9.75	9.25 – 9.75	9.25 – 9.75
200—No. 3	9.50 –11.00	9.50 –11.00	9.50 –11.00
200—No. 4	9.50 –10.75	9.50 –10.75	9.50 –10.75
200—No. 5	8.50 –10.50	8.50 –10.50	9.00 –10.50
220—No. 3	12.50 –13.50	12.50 –13.50	12.50 –13.50
220—No. 4	12.25 –12.50	12.25 –12.50	12.25 –12.50
220—No. 5	11.50 –12.00	11.50 –12.00	11.50 –12.00
240—No. 3	14.00	14.00	14.00
240—No. 4	13.50	13.50	13.50
240—No. 5	12.00 –13.00	12.00 –13.00	12.00 –13.00
280—No. 3	16.00 –17.00	16.00 –17.00	16.00 –17.00
280—No. 4	15.25	15.25	15.25
280—No. 5	14.00 –15.00	14.00 –15.00	14.00 –15.00
300—No. 5-6	17.00	17.00	17.00
GULF COASTAL			
Vis. Color	**(Viscosity at 100° F., pour test 0)**		
100—No. 2 Unfilt. Pale	7.00 – 7.50	7.00 – 7.50	7.50 – 8.00
200—No. 3 Unfilt. Pale	9.50 –10.00	9.25 –10.00	9.25 –10.00
300—No. 3 Unfilt. Pale	10.50 –11.50	10.50 –11.50	10.50 –11.50
500—No. 3½ Unfilt. Pale	12.50 –13.00	12.00 –13.00	12.00 –13.00
750—No. 4 Unfilt. Pale	15.50 –16.00	14.50 –15.50	14.50 –15.00
200—No. 5½ Red Oil	8.00 – 8.50	7.50 – 8.00	7.50 – 8.00
300—No. 5½ Red Oil	9.50 –10.00	9.00 –10.00	9.00 –10.00
500—No. 6 Red Oil	10.50 –11.50	10.25 –11.25	10.25 –11.25
750—No. 6 Red Oil	13.50 –14.00	13.00 –14.00	13.00 –14.00
CALIFORNIA			
Vis. Color	**(Viscosity at 100°F.)**		
100—No. 2	9.00 – 9.50	9.00 – 9.50	9.00 – 9.50
100—No. 3	7.50 – 8.00	7.50 – 8.00	7.50 – 8.00
200—No. 3	9.50 –10.00	9.50 –10.00	9.50 –10.00
300—No. 3	10.50 –11.00	10.50 –11.00	10.50 –11.00
450—No. 3-3½	13.00 –13.50	13.00 –13.50	13.00 –13.50
550—No. 3-3½	14.50 –15.00	14.50 –15.00	14.50 –15.00
600—No. 3-3½	15.00 –15.50	15.00 –15.50	15.00 –15.50
100—No. 5	6.50	6.50	6.50
200—No. 5	8.00 – 8.50	8.00 – 8.50	8.00 – 8.50
300—No. 5	9.00 – 9.50	9.00 – 9.50	9.00 – 9.50
400—No. 5	11.00 –11.50	11.00 –11.50	11.00 –11.50
500—No. 5	11.00 –11.50	11.00 –11.50	11.00 –11.50
600—No. 5	12.00 –12.50	12.00 –12.50	12.00 –12.50
700—No. 7	14.00 –14.50	14.00 –14.50	14.00 –14.50

CYLINDER STOCKS

****OKLAHOMA**			
190-200 Vis. at 210° Brt. St.	31.00 –32.00	31.00 –32.00	31.00 –32.00
150-160 Vis. at 210° Brt. St.	25.00 –27.00	25.00 –27.00	25.00 –27.00
600 E St. 140-150 Vis.-210°	17.00 –18.00	17.00 –18.00	17.00 –18.00
600 St. Ref. Olive Green	9.00 –10.00	9.00 –10.00	9.00 –10.00
600 St. Ref. Dark Green	7.00 – 8.00	7.00 – 8.00	7.00 – 8.00
Black Oil	5.00	5.00	5.00
PENNSYLVANIA	**(1-inch Immersion Test)**		
600 Steam Refined	9.00 –10.00	9.50 –10.50	9.50 –10.25
650 Steam Refined	11.50 –12.50	12.00 –12.50	12.00 –12.50
600 Flash	16.50 –17.50	16.00 –17.00	16.00 –17.00
625 Flash	27.00 –28.00	27.00 –28.00	27.00 –28.00
600 Warren E	18.00 –19.00	18.00 –19.00	18.00 –19.00
600 Oil City E	17.00 –17.50	17.00 –17.50	17.00 –17.50
600 D Filtered	25.50 –26.00	25.50 –26.00	25.50 –26.00
Cold Test Stocks (brt. filt.)	34.50 –35.50	34.50 –35.50	35.00 –36.00
Cold Test Stock (dark filt.)	33.00 –34.00	33.00 –34.00	33.00 –34.00

(Note—Prices of total immersion test goods average 1 to 3 cents per gallon higher)

†PRICES NOMINAL ††ONLY ONE REFINER QUOTING *QUOTATIONS ONLY **REPRESENTS BOTH SALES AND QUOTATIONS

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Lubricating Oil Plants, including complete compounding equipment
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Interested in .....

Size ..... Truck .....

Other Equipment .....

Name .....

Address .....

Refinery Markets on Wax and Heavy Oil Products

Prices given below are in cents per gallon, F. O. B. refinery, except where $ is shown

(For quick reference to Refinery prices, get the OIL PRICE HANDBOOK, published annually)

WAX

PENNSYLVANIA Per Pound, New York	Prices Sept. 19	Prices Sept. 12	Prices Sept. 6
122-124 white crude scale.	3.00 – 3.125	3.125	3.00 –3.125
124-126 white crude scale.	3.00 – 3.125	3.125	3.00 –3.125
OKLAHOMA			
**124-126 Semi-refined...	2.75 – 3.00	2.75 – 3.00	2.625– 2.875
CALIFORNIA			
White crude scale, per pound	6.00 – 7.00	6.00 – 7.00	6.00 – 7.00

FUEL OIL

PENNSYLVANIA			
36-40 fuel oil.	4.50 – 4.75	4.625– 4.75	4.625– 4.75
30-34 fuel oil	4.50 – 4.75	4.50 – 4.75	4.50 – 4.75
28-32 fuel oil	4.50 – 4.75	4.50 – 4.75	4.50 – 4.75
OKLAHOMA			
38-40 straw distillate	3.125– 3.25	3.125– 3.25	3.125 – 3.25
36-38 straw distillate	3.00	3.00	3.00
32-36 gas oil, cracked	2.50 – 2.625	2.50 – 2.625	2.50 – 2.625
32-36 gas oil, str. reduced	2.50 – 2.625	2.50 – 2.625	2.50 – 2.625
28-30 fuel oil (in bbls.)	$0.95 – 1.00	$0.95 – 1.00	$0.95 –$1.00
26-28 fuel oil (in bbls.)	$0.90 – 0.95	$0.90 – 0.95	$0.90 –$0.95
24-26 fuel oil (in bbls.)	**$0.85– 0.875	**$0.85 – 0.875	**$0.85–$0.875
22-26 fuel oil (in bbls.)	**$0.825– 0.85	**$0.825– 0.85	**$0.825–$0.85
18-22 fuel oil (in bbls.)	**$0.775–0.825	**$0.775– 0.825	**$0.775–$.825
16-18 fuel oil (in bbls.)	**$0.75– 0.80	**$0.75 – 0.80	**$0.75–$0.80
14-16 fuel oil (in bbls.)	**$0.75– 0.80	**$0.75 – 0.80	**$0.75–$0.80
KANSAS (F. O. B. refinery Kansas destination.)			
38-40 straw distillate	3.50 – 3.75	3.50 – 3.75	3.50 – 3.75
36-38 straw distillate	3.25 – 3.50	3.25 – 3.50	3.25 – 3.50
32-36 gas oil	2.75 – 2.875	2.75 – 2.875	2.75 – 2.875
24-26 gas oil	*$0.95– 1.05	*$0.95 – 1.05	*$0.95 –$1.05
18-22 fuel oil	*$0.85– 0.90	*$0.85 – 0.90	*$0.85 –$0.90
NORTH TEXAS			
38-40 straw distillate	3.00	3.00	3.00
32-36 gas oil, cracked	2.50	2.50	2.25 – 2.375
32-36 gas oil, uncracked	2.50	2.50	2.25 – 2.375
24-26 fuel oil (in bbls.)	$0.80 – 0.825	$0.80	$0.775– 0.80

GULF COASTAL	Prices Sept. 19	Prices Sept. 12	Prices Sept. 6
Fuel (in bbls.)	$1.60 –$1.65	$1.60 –$1.65	$1.60 –$1.65
Gas oil	4.00 – 4.25	4.00 – 4.25	4.00 – 4.25
NORTH LOUISIANA (For Louisiana and differential territory destination)			
32-36 gas oil, dark	3.00 – 3.125	3.00 – 3.125	3.00
32-36 gas oil, straw	3.00 – 3.125	3.00 – 3.125	3.00
16-20 fuel oil (in bbls.)	$1.10 – 1.125	$1.10 – 1.15	$1.10 –$1.15
ARKANSAS (For Arkansas intrastate shipment only)			
32-36 gas oil	3.25 – 3.375	3.25 – 3.375	3.25 – 3.375
28-32 gas oil	3.00 – 3.25	3.00 – 3.25	3.00 – 3.25
Road oil	$1.25 – 1.30	$1.25 – 1.30	$1.25 –$1.30
ARKANSAS (F. O. B. Arkansas refineries for interstate shipment)			
28-32 gas oil	2.75 – 3.00	2.75 – 3.00	2.75 – 3.00
Smackover crude fuel	$1.10 – 1.15	$1.10 – 1.15	$1.10 – 1.15
Road oil	$1.15 – 1.25	$1.15 – 1.25	$1.15 – 1.25
CALIFORNIA (F. O. B. San Joaquin Valley. At San Francisco, 4c per bbl. more)			
14-18 fuel oil (in bbls.)	$0.65 –$0.90	$0.65 –$0.90	$0.65 –$0.90
14-18 Bunker oil (in bbls.)	$0.85 –$1.00	$0.85 –$1.00	$0.85 –$1.00
30-34 gas oil (in bbls.)	$0.90 –$1.00	$0.90 –$1.00	$0.95 –$1.05
27 Plus Diesel oil (in bbls.)	$0.85 –$1.00	$0.85 –$1.00	$0.85 –$1.00
NEW ENGLAND			

These prices have been discontinued in this table and will appear hereafter in the Seaboard market for Boston.

PETROLATUMS

PENNSYLVANIA (In cents per pound in tank cars; in barrels, in car lots ¾c per pound more.)			
Snow White	8.50	7.50 – 7.75	7.50 – 7.75
Lily White	7.50	6.50	6.50
Cream White	6.50	5.50	5.50
Light Amber	4.00	2.875– 3.00	2.875– 3.00
Amber	3.75	2.625– 2.75	2.625– 2.75
Red	3.125	2.375	2.375
Green No. 5 color	2.50	1.75	1.75

**PETROLEUM COKE

(Per ton in car lots)

Lump	$5	$5	$5
Still run	$3	$3	$3
Breeze	$2	$2	$2

† Prices Nominal. †† Only one refiner quoting. * Quotation only. ** Represents both sales and quotations.

(*Continued from page* 353)

mand through the winter months due to the light straw color and the zero cold test. The Louisiana gas oil last season was sold in competition to stove distillates in many sections of the north.

Fuel oils in Oklahoma have shown no price changes so far this month. Demand is about normal, a majority of refiners report, shipments about balancing production. The warmer weather recently slowed up the demand for higher gravities, but not sufficiently to cause any price recessions. Texas refiners are fairly well sold up on fuel oils to industrials and railroads, and the demand from gins is helping this commodity as well as gas oil.

Oklahoma refiners manufacturing wax report they are for the most part completely sold up for September, and are hesitant to quote over October. Sales were made at 2.75 to 3 cents.

Formation of Ohios' 14 Oil Clubs Completed

CLEVELAND, Sept. 19.—Organization of 14 local petroleum clubs has been completed in Ohio with the assistance of W. A. Milne, secretary of the Ohio Petroleum Marketers Association, and a schedule of meeting has been drafted for October, November, December, January, March, April, May and June. No club meetings have been scheduled for February when the annual meeting of the state association with equipment exhibits will be held in the Neil House, Columbus, Feb. 23 and 24. Speakers for meetings of local clubs are supplied by the state association.

Local clubs and their officers are:

Ohio Valley—D. M. Reese, Ohio Distributing Co., Gallipolis, president; J. C. Mead, Biedel & Mead Oil Co., Athens, secretary.

Scioto Valley—Newell B. Phillips, Jackson County Oil Co., Wellston, president; E. J. O'Donnell, O'Donnell Oil Co., Chillicothe, secretary.

Cincinnati—E. V. Weber, Eureka Oil Co., Reading, president; Fred T. Boeschlin, Caldwell & Taylor, Inc., Cincinnati, secretary.

Miami Valley—Walter Bell, Gerkins Oil Co., Dayton, president; Paul E. Conder, Indian Refining Co., Dayton, secretary.

Southeastern Ohio—J. W. Thomson, Thomson Gasoline Co., Coshocton, president; Clifford H. Wagoner, Wagoner Oil Co. Zanesville, secretary.

Eastern Ohio—O. U. Latto, Latto Oil Co., Uhrichsville, president; I. E. Hunt, Valley Home Service Co., Bridgeport, secretary.

Mahoning Valley—J. L. Marsh, Vahey Oil Co., Youngstown, president; William Lyden, Lyden Oil Co., Youngstown, secretary.

Tri-County—C. J. Maier, White Star Oil Co., Akron, president; S. E. McFarren, C. A. Pierce Oil Co., Akron, secretary.

Western Reserve—R. C. Heil, Commercial Oil Co., Cleveland, president; J. G. Malone, Indian Oil Products Co., Cleveland, secretary.

Maumee Valley—T. L. Cameron, Cameron Oil Co., Toledo, president; H. O. Green, Empire Petroleum Co., Toledo, secretary.

Lake Shore—F. A. Adelman, Firelands Oil Co., Norwalk, president; L. H. Rogers, Rogers Oil Co., Lorain, secretary.

Lima District—Thomas B. Snow, Econ Oil & Gas Co., president; John J. Klay, Parks-Klay Oil Co., Lima, secretary.

Four Square—H. L. Avery Oil & Grease Co., Ashland, president; R. K. Shoolroy, Arrow Oil Co., Wooster, secretary.

Central Ohio—E. Quimby Smith, Sterling Petroleum Co., Mt. Sterling, president; R. W. Palmer, Accurate Measure Oil Co., secretary.

Middle West Heat Wave Brings Better Gasoline Demand

Staff Special
CHICAGO, Sept 17

THE heat wave which spread over the middle west last week continued this week with unusually high temperatures for the time of year. Evening motoring took on its usual hot weather popularity and jobbers reported good gallonage as a result. All of this brought on good demand for gasoline from the jobbing trade in the Chicago resale market, especially toward the last of the week.

Price of 58-60 U. S. Motor gasoline was 6.125 to 6.25 cents. Several sellers raised their quotations to 6.25 cents flat Saturday. Several marketers reported increasing difficulty in buying gasoline under 6.125 cents for resale from Group 3. Some sales under 6.125 cents were reported early in week but these diminished in number as demand improved.

High test gasolines were quiet generally during the week. Prices were firm and practically unchanged. The 60-62, 437 e. p. grade moved at a flat price of 6.25 cents all week; 60-62, 400 e. p. sold at 6.375 to 6.625 cents over first half of the week, advancing to 6.50 to 6.625 cents on Thursday and remained there over Saturday. The 64-66, 375 e. p. gasoline opened at 6.75 to 7 cents, dropped slightly to 6.75 to 6.875 cents on Tuesday and closed the week at those figures.

Conflicting reports were heard about kerosene. In some quarters demand was reported good throughout the week. Other sellers said they had only fair business. Bulk of 41-43 w. w. sales was at 4.25 cents over the week. Some material at 4.125 cents was available during the week but was less in evidence at the close. Some sales were reported at 4.375 cents.

Distillates and gas oils in general were quiet. Straw zero 32-36 gas oil was reported scarce by most dealers; 38-40 straw distillate was 3.125 to 3.375 cents when week closed after selling at 3.25 to 3.375 cents up to Thursday. The 32-36 ordinary dark gas oil remained steady all week at 2.50 to 2.625 cents. The same material having zero cold test was unsettled during week, opening at 2.625 to 2.875 cents Monday but dropped to 2.625 to 2.75 cents on Tuesday. On Wednesday it reached 2.75 cents flat where it remained until Saturday, returning to 2.625 to 2.75 cents. Straw zero gas oil, 32-36 gravity, was at 3.125 cents flat on Monday. It dropped to 2.875 to 3 cents on Tuesday and remained at those figures until Thursday when it advanced to 2.875 to 3.125 cents at which figures it closed the week. Industrial demand on gas oils was quiet most all week with some sellers reporting a little better demand the last two or three days.

Fuel oils were quiet and unchanged throughout the week. Industrial buying was not much in evidence, with only a few small inquiries in the market. An Ohio industrial was inquiring for 14 cars of 16-22 fuel oil Thursday. Fuel oil of 28-30 gravity was $0.95 to $1.05 while 22-26 and 24-26 grades sold at $0.825 to $0.85 and 18-22 fuel at $0.80 to $0.825. Smackover quotations remained unchanged at $1.10 to $1.15 per barrel.

Mostly fair weather with showers in northern portions of Standard Oil Co. of Indiana territory is forecast for next week. The weather will be close to seasonal normal the first part of the week with rising temperatures toward the end.

NEW YORK, Sept. 20.—On Sept. 20 Standard Oil Co. of New Jersey advanced prices of kerosene in cases for export ½ cent per gallon at New York. Last previous change was ½ cent cut on Apr. 26.

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Week's Price Changes Tank Wagon Markets

Gasoline Changes

Standard of Indiana—T.w. and s.s. prices gasoline reduced 3.2 cents, Decatur, Ill., to 13 and 15 cents respectively, **Sept. 14**, and reduced 2.5 cents, to 10.5 cents and 12.5 cents respectively, **Sept. 15.**

* * *

Magnolia Petroleum—S.s. price only of gasoline reduced 1 cent, Fort Smith, to 17 cents, **Sept. 13.**

Natural Gasoline Assn. To Meet Oct. 15, 16

LOS ANGELES, Sept. 17.—A two day fall meeting of the California Natural Gasoline Association will be held in Los Angeles Oct. 15 and 16, Pres. Geo. L. Ratcliffe announced at the monthly meeting of the organization Thursday. At first it was thought that a joint session of the Natural Gasoline Manufacturers Associations could be held at Los Angeles, but it has been decided that the plan would not be feasible since it has been learned that a large attendance from the Mid-Continent could not be expected.

Dr. G. G. Brown, professor of chemical engineering at University of Michigan, will furnish the program for the second day. Dr. Brown will drive to Los Angeles, using the national association's Lincoln, used in his experimental work. Natural gasoline will be used entirely during the trip, and records kept, permitting Dr. Brown to make reports of his experiences and findings at the Los Angeles meeting.

The first day will be given to reading of a number of prepared papers. There will no night meeting the first day. Dr. Brown will have all of the second day, and at night a banquet will be held. The sessions will be held at the Biltmore. It is understood in Los Angeles that about 20 members of the national association will come to Los Angeles for the meeting.

R. E. Davis Opens Tulsa Office

Ralph E. Davis, consulting geologist and petroleum engineer, will open an office in Tulsa, Oct. 1 in the Tulsa Trust Co. building. Mr. Davis now maintains offices in Pittsburgh, where he lives; in Shreveport, La., and Charleston, W. Va. The Tulsa office will be directed by Paul Ruedemann, geologist and specialist in valuation work, formerly in the oil and gas section of the internal revenue department; later chief engineer for Johnson, Huntley & Somers, Pittsburgh and for several years production manager for Thompson & Black, in Tulsa. He has resigned from the latter position to take up his new work.

Tank Wagon, Service Station Markets for Gasoline and Kerosene In United States Territories and Canada

(OIL PRICE HANDBOOK has t.w. and s.s. markets for whole year arranged for quick reference)

These Prices In Effect September 19, 1927

S.O. NEW JERSEY TERRITORY

	Gasoline T.W.	Tax	Total T.W.	S.S.	Oil T.W.
Atlantic City, N. J.	16	2	18	20	14
Newark, N. J.	16	2	18	20	14
Annapolis, Md.	16	4	20	23	12
Baltimore, Md.	16	4	20	23	10
Cumberland, Md.	16	4	20	23	14
Washington, D. C.	16	2	18	21	12
Danville, Va.	16	4½	20.5	*	14
Norfolk, Va.	16	4½	20.5	23.5	12
Richmond, Va.	14	4½	18.5	21.5	14
Roanoke, Va.	16	4½	20.5	23.5	14
Petersburg, Va.	16	4½	20.5	23.5	14
Williamsburg, Va.	16	4½	20.5	23.5	14
Charleston, W. Va.	16	4	20	23	14
Clarksburg, W. Va.	16	4	20	21	14
Keyser, W. Va.	16	4	20	*	14
Parkersburg, W. Va.	13	4	17	20	14
Wheeling, W. Va.	16	4	20	23	14
Charlotte, N. C.	16	4	20	23	14
Hickory, N. C.	16	4	20	23	14
High Point, N. C.	16	4	20	20	14
Mt. Airy, N. C.	16	4	20	23	14
Salisbury, N. C.	16	4	20	23	14
Charleston, S. C.	15	5	20	23	14
Columbia, S. C.	15	5	20	23	14

*Dealers set own prices. S. O. New Jersey does not operate station.

S. O. NEW YORK

Due to local price conditions at many points in S. O. New York territory, actual prices on both gasoline and kerosene are being made at under the posted tank wagon prices published below.

*New York City	17	0	17	21	15
Albany, N. Y.	17	0	17	19	15
Buffalo, N. Y.	15	0	15	18	14
†Rochester, N. Y.	13	0	13	16	13
Syracuse, N. Y.	17	0	17	19	15
Boston, Mass.	17	0	17	18	15
Augusta, Me.	17	3	20	22	15
Manchester, N. H.	17	2	19	21	15
Burlington, Vt.	17	3	20	22	15

*In steel barrels.

†It is reported that S. O. New York is selling a second grade of gasoline at Rochester, 4c below the above posted prices which apply on its Socony grade.

ATLANTIC REFINING

Pittsburgh, Pa.	16	*	16	*22	14
Philadelphia, Pa.	15	*	15	*21	14
Allentown, Pa.	16	*	16	*22	14
Erie, Pa.	12	*	12	*18	14
Scranton, Pa.	16	*	16	*22	14
Altoona, Pa.	16	*	16	*22	14
Dover, Del.	16	3	19	22	14
Wilmington, Del.	16	3	19	22	14
Providence, R. I.	17	2	19	19	15
Boston, Mass.	17	0	17	17	15
Springfield, Mass.	17	0	17	17	15
Worcester, Mass.	17	0	17	17	15
Hartford, Conn.	19	2	21	22	15
New Haven, Conn.	19	2	21	21	15

*3-cent state tax is collected by retail dealer and paid by him directly to state.

S. O. KENTUCKY

Lexington, Ky.	13	5	18	21	15.5
Louisville, Ky.	14	5	19	22	15
Covington, Ky.	14	5	19	22	15.5
Clarksdale, Miss.	13	4	17	20	12.5
Gulfport, Miss.	††14.5	4	††18.5	21.5	14
Jackson, Miss.	13	4	17	20	13.5
Natchez, Miss.	12.5	4	16.5	19.5	14
Vicksburg, Miss.	12.5	4	16.5	19.5	14
Birmingham, Ala.	14	4	18	21	15.5
Mobile, Ala.	13	4	17	20	15
Montgomery, Ala.*	15	4	19	22	16.5
Atlanta, Ga.	12	4	16	18	†15.5
Augusta, Ga.	15	4	19	22	†16.5
Macon, Ga.	15	4	19	22	†16.5
Savannah, Ga.	12	4	16	18	†14.5
Jacksonville, Fla.°	10	5	15	18	14
Miami, Fla.°	12	5	17	20	15.5
Tampa, Fla.°	9	5	14	17	14
Pensacola, Fla.°	**11	5	**16	19	15

*Local privilege tax of 1 cent on gasoline and ½ cent on kerosene at Montgomery included.

†Georgia kerosene prices include 1c state tax.

°Florida gasoline prices include ⅛c inspection fee.

**Both tank wagon prices include 1c city tax at Pensacola, which went into effect Oct. 15, 1926.

††Both tank wagon prices at Gulfport include Harrison county privilege tax of 2c.

S. O. INDIANA

	Gasoline T.W.	Tax	Total T.W.	S.S.	Oil T.W.
Chicago, Ill.	14	2	16	18	12
Decatur, Ill.	8.5	2	10.5	12.5	12.1
E. St. Louis, Ill.	13.1	2	15.1	17.35	11.2
Joliet, Ill.	14.4	2	16.4	18.4	12.3
Peoria, Ill.	10	2	12	12	12.1
Quincy, Ill.	14.2	2	16.2	18.2	11.9
Indianapolis, Ind.	14.2	3	17.2	19.2	13.2
Evansville, Ind.	14	3	17	19	13
South Bend, Ind.	14.4	3	17.4	19.4	13.4
Detroit, Mich.	14.8	3	17.8	19.8	13.7
Grand Rapids, Mich.	14.7	3	17.7	19.7	13.6
Saginaw, Mich.	14.9	3	17.9	19.9	13.8
Green Bay, Wis.	14.6	2	16.6	18.6	12.4
Madison, Wis.	14.3	2	16.3	18.3	12.1
Milwaukee, Wis.	14.1	2	16.1	18.1	11.9
La Crosse, Wis.	15.2	2	17.2	19.2	13
Minneapolis, Minn.	12	2	14	14	12.9
Duluth, Minn.	13.5	2	15.5	17.5	12.9
Mankato, Minn.	15.1	2	17.1	19.1	12.7
Des Moines, Ia.	14	3	17	19	12.3
Davenport, Ia.	14.5	3	17.5	19.5	12.3
Sioux City, Ia.	14.1	3	17.1	19.1	11.9
Mason City, Ia.	14.5	3	17.5	19.5	12.3
St. Louis, Mo.	*13.6	2	15.6	17.9	11.3
Kansas City, Mo.	†12.9	2	14.9	16.9	10.6
St. Joseph, Mo.	†12.5	2	14.5	16.5	11.2
Fargo, N. D.	15	2	17	19	14.9
Grand Forks, N. D.	17.2	2	19.2	21.2	15.2
Minot, N. D.	16.9	2	18.9	20.9	14.9
Fierre, S. D.	15.5	4	19.5	21.5	13.9
Huron, S. D.	12.5	4	16.5	18.5	13.9
Wichita, Kans.	12.8	2	14.8	17.8	10.8
Bartlesville, Okla.	12.8	3	15.8	17.8	10.8

S. O. Indiana Q. D. A. schedule on tank wagon deliveries of gasoline, effective March 3 thru territory, except Wisconsin effective March 4: 50 gals. and over on delivery, 1c discount, except in city of Chicago where 1c discount applies on 100 gals. and over; 6,000 gals. and over per month, 1½c; 10,000 gals. and over per month, 2c; 15,000 gals. and over per month 3c, except latter discount does not apply in Chicago.

Service station discounts: 200 gals. or more per month, and 2,400 gals. or more per year, 2c per gal.

March 1, 1c discount on kerosene in 50 gal. dumps thru territory.

*Includes city tax of ½c.

†Includes city tax of 1c.

S. O. NEBRASKA

Omaha, Neb.	14.25	2	16.25	16.25	12.25
McCook	12.75	2	14.75	16.75	11.50
Norfolk	14.75	2	16.75	18.75	12.75
North Platte	15.75	2	17.75	19.75	13.50
Scottsbluff	15.25	2	17.25	19.25	13.00

CONTINENTAL OIL

Denver, Colo.	15	3	18	20	12.5
Pueblo, Colo.	15	3	18	20	14.5
Grand Junction, Colo.	18.5	3	21.	23.5	18
Casper, Wyo.	15	3	18	20	13
Cheyenne, Wyo.	16	3	19	21	14.5
Butte, Mont.	19	3	22	22	19
Helena, Mont.	19.5	3	22.5	24.5	19
Salt Lake City, Utah	17.5	3½	21	23	17
Boise, Ida.	19.5	4	23.5	25.5	19
Twin Falls, Ida.	19.5	4	23.5	25.5	19
Albuquerque, N. M.	16	5	21	24	17

S. O. CALIFORNIA

Phoenix, Ariz.	19	3	22	26	21.5
Los Angeles, Cal.	13.5	3	16.5	20.5	15.5
Fresno, Cal.	14	3	17	21	16.5
San Francisco, Cal.	14	3	17	21	15.5
Reno, Nev.	18	4	22	26	19
Portland, Ore.	14.5	3	17.5	21.5	16.5
Seattle, Wash.	14.5	2	16.5	20.5	16.5
Spokane, Wash.	18.5	2	20.5	24.5	20.5
Tacoma, Wash.	14.5	2	16.5	20.5	16.5

S. O. LOUISIANA

Little Rock, Ark.	13	5	18	21	12
Alexandria, La.	13	2	15	18	†14
Baton Rouge, La.	12	2	14	17	†12.5
Lake Charles, La.	13.5	2	15.5	18.5	†14
New Orleans, La.	*12.5	2	*14.5	*18.5	*14
Shreveport, La.	13.5	2	15.5	18.5	†13
Lafayette, La.	13	2	15	18	†13.5
Bristol, Tenn.	16	3	19	22	14
Chattanooga, Tenn.	16.5	3	19.5	22.5	15
Knoxville, Tenn.	16.5	3	19.5	22.5	15
Nashville, Tenn.	15	3	18	21	15
Memphis, Tenn.	12	3	15	18	14

*New Orleans gasoline prices include 1c parish tax in addition to 2c state tax, and kerosene prices include 1c state tax and 1c parish tax.

†Kerosene price in Louisiana includes 1c state tax.

S. O. OHIO

	Gasoline T.W.	Tax	Total T.W.	S.S.	Oil T.W.
All Ohio points	16	3	19	21	14

MAGNOLIA PETROLEUM

Muskogee, Okla.	12	3	15	18	9
Oklahoma City	12	3	15	18	9
Tulsa, Okla.	12	3	15	18	9
Fort Smith, Ark.*	11	*3	14	17	12
Little Rock, Ark.	11	5	16	18	12
Texarkana, Ark. *	12	*3	15	18	12
Dallas, Tex.	14	3	17	17	11
Fort Worth, Tex.	13	3	16	16	10
Houston, Tex.	14	3	17	17	15
San Antonio, Tex.	13	3	16	16	11
El Paso, Tex.	15	3	18	18	16

*Within City of Texarkana and Fort Smith, the state tax on gasoline is 3c per gal. conforming with the Texas state tax. In these two districts outside of the city the 5c Arkansas tax applies.

V. M. & P. NAPHTHA

(Changes ordinarily occur coincident with gasoline price changes)

	Oleum Spirits	V.M. & P. Naphtha	Cleaner Naphtha
Chicago	16	18	18
Detroit	17.7	19.7	19.7
Kansas City	16.2	†18.2	†18.2
Milwaukee	16.7	*20.7	*20.7
Minneapolis	*20	*22	*22
St. Louis	15.9	17.9	17.9
New York		19	

*Includes 2c state tax.

†Includes 1c city tax.

CANADA

(Per Imperial Gallon, which is 1.2 American Gallons)

ONTARIO

	Gasoline T.W.	Tax	Total T.W.	S.S.	Oil T.W.
Toronto	19.5	3	22.5	26	21
Ottawa	19.5	3	22.5	26	21
Cochrane	24.5	3	27.5	36	26
Ft. William	24.5	3	27.5	31	23.5

MANITOBA

Winnipeg	24.5	3	27.5	31	23.5

SASKATCHEWAN

Regina	27.5	0	27.5	32	26.5

ALBERTA

Edmonton	26.5	3	29.5	33	25.5
Calgary	24.5	3	27.5	31	23.5

BRITISH COLUMBIA

Vancouver	21	3	24	27	22

QUEBEC

Montreal	20.5	3	23.5	27	21
Quebec City	22.5	3	25.5	31	23
Three Rivers	22.5	3	25.5	30	23

NEW BRUNSWICK

St. John	24.5	3	27.5	32	24
Moncton	24.5	3	27.5	32	24

NOVA SCOTIA

Halifax	24.5	3	27.5	32	24
Sydney	26.5	3	29.5	34	26

PRINCE EDWARD ISLAND

Charlottetown	24.5	3	27.5	31	24

Note: In districts surrounding these points 1c additional is added to city price.

Gasoline Demand is Good in East; Kerosene Price is Advanced

Staff Special
NEW YORK, Sept. 17

A COMPARATIVELY good demand from the jobbing trade for gasoline and a slightly more active demand for kerosene gave considerable optimism to oil markets along the Atlantic seaboard this week. Although a few sellers in New York and Philadelphia were willing to take orders for U. S. Motor gasoline at 8 cents, there was a better feeling about the gasoline market than for some time past.

Numerous eastern oil men attended the silver anniversary of the National Petroleum Association at Atlantic City, but the marketers and refiners who remained in their offices the three days the meeting lasted, reported a heavy movement of gasoline on contract. One refiner asserted he was just catching up with orders received since Labor Day.

Weather along the seaboard again broke favorably for the motorist last week end the weather man's forecast for the coming week end is that temperatures will continue high and the weather generally fair. The trade is looking for September business to make up for slackness due to the bad weather in August. Indications are it will not be disappointed.

Gasoline markets opened Monday with U. S. Motor 8.25 cents a gallon in tank cars at Philadelphia and New York. Most sellers reported the usual run of Monday business. However, Tuesday one or two concerns that were pressed for orders, found it necessary to take on some business at 8 cents. They state that customers whom they had considered their regular outlets, were placing orders with other sources of supply which indicated to them that they were being underquoted. They automatically reduced their quotations to 8 cents. Reports that leading refiners were selling U. S. Motor gasoline for 8 cents could not be confirmed. Most refiners said they were not even meeting competition at this figure.

Not much was heard from what are generally termed the leading price cutting centers in the east, Boston and Philadelphia. Apparently price cutters in these markets found business too rushing to make lowering of prices necessary to get gallonage. Tank wagon prices in those cities were steady, and subsequently refinery prices fluctuated less, particularly at Boston.

Kerosene prices toward the end of the week showed a tendency to advance in view of increased jobbing interests. Doubtless the higher prices prevailed in other refinery markets had something to do with the upward tendency.

Standard Oil Co. of New Jersey Sept. 15 advanced the tank car price of its water white kerosene to 7 cents a gallon. Most sellers in New York quoted 41-43 prime white kerosene at 6.50 cents. At Philadelphia 43-45 water white was held at 6.50 to 6.75 cents.

Demand for furnace oil and gas oil improved slightly but quotations by the majority of sellers were not changed. It was generally felt that as soon as active fall demand sets in for the heavier burning oil, prices will rally quickly.

Grade C fuel oil for bunkering was in good demand at New York harbor and it was doubtful if $1.65, which has been the ruling market for several weeks, could be shaded. Diesel oil was steady at $2.10 a barrel.

Gulf Export Markets are Quiet; Burning Oil Prices Stiffen

Staff Special
NEW YORK, Sept. 17

EXPORT markets at the Gulf experienced an unusually quiet week. Interest of foreign buyers lagged with the result that only one cargo transaction was reported closed.

While demand for kerosene and gas oil showed little if any improvement, prices for these oils were showing a tendency to advance, breaking away from the levels they have held for the past several months. Kerosene, particularly, has fluctuated less than any other commodity in the Gulf market in the last six months, and talk of higher prices aroused considerable interest among exporters this week.

Prime white and water white kerosene have been listed at 5 cents and 6 cents, respectively, by most refiners in this market. It is doubtful if they have been shaded. One imporant exporter advanced his price for prime white to 5.25 cents late this week.

The single inquiry in the market this week, from a French buyer, was for 60,000 barrels of 64-66, 375 end point gasoline and 16,000 barrels of prime white kerosene. The inquiry was closed toward the end of the week with the 64-66 reported selling at 8.25 cents and the kerosene at 5 cents. The business was taken by a leading Independent refiner for the French subsidiary of another refiner. Well informed sources in the trade were inclined to believe the business went at 8 cents for the 64-66.

Absence of inquiries for U. S. Motor gasoline makes the market for this commodity somewhat uncertain. One or two refiners continued to list 7.50 cents for this grade while others believed that as low as 7 cents could be done on firm bid. The majority of exporters, however, listed this grade at 7.25 cents, and 64-66, 375 end point gasoline at 8.25 cents with less possibility of shading the latter price.

Inquiries for cased goods were routine and prices were held in line with prices for bulk shipments. There was some talk that $1.60 could be shaded for U. S. Motor gasoline in cases, but no business was reported placed at this figure.

Brokers reported it hard to obtain quotations on gas oil, and 3.875 cents for 26-28 translucent and 4 cents for 30-32 translucent were acknowledged the ruling prices for cargo lots for spot shipment.

No cargo transactions of heavy oil were closed this week, but offers of Grade C at $1.25 a barrel were still made with some sellers asking as high as $1.30.

Quotations for heavy Panuco crude at Tampico were up 3 cents a barrel to $1.15; the last business closed on this oil went at $1.10 a barrel. Grade C oil for bunkering, f.o.b. steamer, Tampico, held steady at $1.50 a barrel.

Wax prices at the Gulf showed little if any deviation from quotations a week ago. White crude scale was largely held at 3 cents a pound with fully refined goods 1 cent more. The usual volume of small orders was reported in the market.

Lubes are More Active In New York Market

NEW YORK, Sept. 17.—Quotations on 600 steam refined unfiltered cylinder stock were 17 to 18 cents this week. A week ago exporters in the New York market were asking only 16 cents. Lubricating oils were more active this week, some of the activity being attributed to the extensive motoring made possible by good September weather.

The wax market was quiet, with only the usual run of small orders. One or two sellers, on the strength of a reported scarcity of goods for spot shipment, have advanced their quotations 0.125 to 0.25 cents a pound

Complete Seaboard Market

(Export markets for whole year given in OIL PRICE HANDBOOK. Each volume carries refinery, tank wagon, crude and export markets—complete for the years 1924-1925-1926)

Eastern Domestic Markets

(Prices in bulk except where otherwise noted f.o.b. refinery or seaboard plant)

	Sept. 19	Sept. 12
U. S. Motor gasoline, tank cars, New York Harbor	8.00 – 8.25	8.25
U. S. Motor gasoline, tank cars, Philadelphia	8.00 – 8.25	8.25
U. S. Motor gasoline, tank cars, Baltimore	8.25 – 8.50	8.25 – 8.50
U. S. Motor gasoline, tank cars, Boston	8.50	8.50 – 8.75
U. S. Motor gasoline tank cars, Norfolk	8.00 – 8.50	
U. S. Motor gasoline tank cars, Charleston	8.00	
U. S. Motor gasoline tank cars, Jacksonville	7.75 – 8.00	
U. S. Motor gasoline tank cars, Providence	8.50	
U. S. Motor gasoline tank cars, Savannah	7.75 – 8.00	
California U. S. Motor gasoline, tank cars, Philadelphia	8.00 – 8.25	8.25
California U. S. Motor gasoline, tank cars, Baltimore	8.25 – 8.75	8.25 – 8.75
41-43 w.w. kerosene, New York	6.50	6.25 – 6.50
41-43 w.w. kerosene, Philadelphia	6.50 – 6.75	6.50
41-43 p. w. kerosene, Boston	6.625	6.50
28-34 gas oil, New York	5.00	5.00
28-34 gas oil, Boston	5.00	5.25
38-42 furnace oil, New York	6.00	6.00
36-40 Furnace Oil, Boston	6.25	6.25 – 6.50
Grade C bunker oil, New York	$1.65	$1.65
Grade C bunker oil, Boston	$1.65 –$1.70	$1.70
Diesel oil, New York	$2.10	$2.10

New York Export Market

(Gasoline and kerosene in cases in bulk. Lubricating oils are all Penna. products, prices per gal. in bbls.)

	Sept. 19	Sept. 12
U. S. Motor gasoline	24.40	24.40
43-45, 150 w.w. kerosene	17.15	17.15
42-44, 110 s.w. kerosene	16.15	16.15
CYLINDER OILS		
Bright stock, dark	40.00 –41.00	40.00 –41.00
Filtered D 600	31.00 –32.00	31.00 –32.00
Filtered E 600 Warren	25.00 –26.00	25.00 –26.00
Unfiltered 600 s.r.	17.00 –18.00	16.00 –18.00
Unfiltered 650 s.r.	19.00 –20.00	19.00 –20.00
600 Flash s.r.	23.00 –24.00	23.00 –24.00
630 Flash s.r.	33.00 –34.00	33.00 –34.00
RED ENGINE OILS (Vis. 100°)		
300 vis. No. 6½ color	20.00	20.00
250 vis. No. 6 color	19.00	19.00
200 vis. No. 6 color	18.50	18.50
PALE ENGINE OILS (Vis. 100°)		
230 vis. No. 3¾ color	24.00	24.00
180 vis. No. 3¼ color	20.00	20.00
100 vis. No. 2¼ color	15.75	15.75
MOTOR OILS (Vis. 100°)		
600 vis. No. 7 color	35.00	35.00
500 vis. No. 6½ color	33.00	33.00
400 vis. No. 7¼ color	31.00	31.00
300 vis. No. 6 color	30.00	30.00
200 vis. No. 3¼ color	24.00	24.00

WAXES (Pa. stocks; in cents per pound, f.a.s. carload lots)

WHITE CRUDE SCALE (In barrels)		
122-124 A.m.p.	3.125– 3.25	3.00 – 3.25
124-126 A.m.p.	3.125– 3.25	3.00 – 3.25
FULLY REFINED (In burlap bags)	**Sept. 19**	**Sept. 12**
123-125 A.m.p. Philadelphia	4.25	4.25
125-127 A.m.p.	4.25	4.25
128-130 A.m.p.	4.25 – 4.375	4.25 – 4.375
130-132 A.m.p.	4.50 – 4.625	4.50 – 4.625
133-135 A.m.p.	*5.75	*5.75
135-137 A.m.p.	*6.00 – 6.50	*6.00
YELLOW CRUDE SCALE		
124-126 A.m.p.	3.00	2.875– 3.00

* Prices Nominal

Gulf Export Market

(F.o.b. Gulf oil terminals in Texas and Louisiana, shipments of 20,000 bbls. and over, except where otherwise noted.)

GASOLINE	**Sept. 19**	**Sept. 12**
U. S. Motor	7.25	7.25
61-63, 390 e.p.	7.75	7.75
64-66, 375 e.p.	8.25	8.25
U. S. Motor, cases (cargo lots)	$1.60 –$1.65	$1.60 –$1.65
64-66, cases (cargo lots)	$1.70 –$1.80	$1.70 –$1.80
KEROSENE		
44 water white	6.00	6.00
41-43 prime white	5.00	5.00
Water white, cases (cargo lots)	$1.55	$1.55
Prime white, cases (cargo lots)	$1.45	$1.45
DOMESTIC GAS AND BUNKER OILS		
*26-28 gas oil	3.875	3.875
*30-32 gas oil	4.00	4.00
Grade C bunker oil	$1.40 –$1.45	$1.40 –$1.45
Grade C bunker oil, cargoes	$1.25 –$1.30	$1.25 –$1.30
*Translucent thru neck of 4 oz. bottle.		
MEXICAN CRUDE AND BUNKER OILS (F.o.b. steamer, Tampico)		
Heavy Panuco crude taxes to be paid	$1.15	$1.12
Grade C bunker oil, for bunkering purposes, taxes paid	$1.50	$1.50
SOUTH TEXAS LUBRICATING OILS (Viscosity at 100°F; cold test 0) (Tanker, f.o.b. Houston)		
100 vis. No. 2 unfiltered pale	6.00 – 6.25	6.00 – 6.25
200 vis. No. 3 unfiltered pale	8.50 – 9.00	8.50 – 9.00
300 vis. No. 3 unfiltered pale	9.50 –10.00	9.50 –10.00
500 vis. No. 3½ unfiltered pale	11.00 –12.00	11.00 –12.00
200 vis. No. 5½ red oil	7.00 – 8.00	11.00 –12.00
300 vis. No. 5½ red oil	8.00 – 9.00	8.00 – 9.00
500 vis. No. 6 red oil	10.00 –10.50	10.00 –10.50

Pacific Export Market

(Quotations are at seaboard, Los Angeles, in cargo lots, cents per gallon, except where otherwise noted.)

	Sept. 19	Sept. 12
Gasoline, U. S. Motor, 53-55 Gravity	6.00 – 7.00	6.00 – 7.00
Gasoline, U. S. Motor, blends and special cuts	7.00 – 8.00	7.00 – 8.00
Gas Oil, 30-34, in bbls.	$0.90 –$1.00	$0.90 –$1.00
Diesel Oil, 27 plus, in bbls.	$0.80 –$1.00	$0.80 –$1.00
Bunker Oil, 14-18, in bbls.	$0.85 –$1.00	$0.85 –$1.00
Fuel Oil, 14-18, in bbls.	$0.80 –$0.90	$0.80 –$0.90
Kerosene, 38-40 w.w., 125-150 flash, in gals.	4.50 – 5.00	4.50 – 5.00
Cased Goods		
Gasoline, U. S. Motor	$1.75 –$1.80	$1.75 –$1.80
Kerosene, 38-40, w.w., 125-150 flash	$1.40 –$1.50	$1.40 –$1.50

for white crude scale. Other sellers say they are receiving offers of 122-124 and 124-126 white crude scale at 3.05 and 3.125 cents permitting them to sell at around 3.125 to 3.25 cents a pound.

The market for most fully refined waxes was generally unchanged. Due to extreme scarcity, quotations on 133-135 and 135-137 A. m. p. grades were largely nominal. The last buying of 135-137 fully refined was at 6.50 cents a pound, but one or two buyers indicated they could do 6 cents on firm bid. Yellow crude scale was quoted 0.125 cent higher at 3 cents.

General superintendent W. M. Ray of the gas and gasoline plant department of Magnolia Petroleum Co., Dallas, is recovering from an operation for appendicitis.

Sale of Jobbing Property To Refiner is Reported

CHICAGO, Sept. 19.—Jacob France of Baltimore, as quoted in an interview with Chicago *Journal of Commerce* last Saturday, confirmed the rumored purchase by Mid-Continent Petroleum Corp., of the recently consolidated Hawkeye and Blackhawk oil marketing properties. Blackhawk Oil Co., at last report owned 475 bulk and service stations.

Since consolidation Blackhawk is said to have distributing facilities in 400 towns in Iowa, Minnesota, Illinois, Indiana and Kentucky. Chicago oil men estimate the transferred properties worth upwards of $2,000,000. The business centers in Waterloo, Iowa, where A. H. Caward founded and built up the original Hawkeye Oil Co., of South Dakota. In the last 10 years the properties have changed hands many times, but the Caward family have never before relinquished financial interest nor physical control.

Together with the properties Mid-Continent already owns in adjacent and overlapping territories, that corporation has retail distribution in nearly 500 towns in and near Iowa.

TULSA, Sept. 17.—The Oklahoma Corporation Commission and its conservation agents will meet representatives of similar departments of other oil producing states Thursday, Sept. 29, at the offices of the Mid-Continent Oil & Gas Association.

Crude Oil Prices, as Posted by Major

(Crude prices for years 1924-1925-1926 in

EASTERN FIELDS

(Posted by Joseph Seep Purchasing Agency)

Penna. Grade Oil in New York Transit Lines (Alleghany, N. Y. District)	$2.65
Bradford District Oil in National Transit Lines (Bradford District)	2.65
Penna. Grade Oil in National Transit Lines (Other Pennsylvania)	2.55
Penna. Grade Oil in Southwest Penna. Pipe Lines (Other Pennsylvania)	2.55
Penna. Grade Oil in Eureka Pipe Lines (West Virginia)	2.50
Penna. Grade Oil in Buckeye Pipe Lines (Macksburg, O. district)	2.25
Keister Grade in National Transit Lines (Butler Co.)	1.10
Cabell Grade in Eureka Pipe Lines (West Virginia)	1.40
Corning Grade in Buckeye Pipe Lines (Ohio)	1.45
Corning, O. heavy grade	1.35
*Somerset Oil in Cumberland Pipe Lines (Kentucky)	1.50
Ragland Grade in Cumberland Pipe Lines (Kentucky)	.95

*Somerset oil run prior to Oct. 1922, takes price of 6 cents lower than above quotations.

(Posted by Stoll Oil Refining Co.)

Oil City, Ky., oil in Stoll Lines.....$1.50

CENTRAL STATES FIELDS

Posted by Ohio Oil Co.

Effective March 14, 1927

Wooster	$1.57	Plymouth	$1.33
Lima	1.71	West. Kentucky	1.33
Waterloo	1.35	*Canadian Petro.	2.11
Indiana	1.48	*Oil Springs	2.18
Princeton	1.60	*Posted by Imperial Oil Ltd.	
Illinois	1.60		

OKLAHOMA, KANSAS And NORTH TEXAS

Prices of Prairie Oil & Gas Co.

(In Oklahoma, Kansas, North and East Central Texas)

Effective March 12, 1927

28-28.9	$1.12	35-35.9	$1.26
29-29.9	1.14	36-36.9	1.28
30-30.9	1.16	37-37.9	1.30
31-31.9	1.18	38-38.9	1.32
32-32.9	1.20	39-39.9	1.34
33-33.9	1.22	40-40.9	1.36
34-34.9	1.24	41-41.9	1.38
42-42.9	$1.40	48-48.9	$1.52
43-43.9	1.42	49-49.9	1.54
44-44.9	1.44	50-50.9	1.56
45-45.9	1.46	51-51.9	1.58
46-46.9	1.48	52 and above	1.60
47-47.9	1.50		

Above schedule met on March 12, by Gulf, Mid-Continent Pet. Corp., and Empire; by Carter, Humble and the Texas Co. on March 14.

Humble Oil & Refining Co. Prices

(Ranger, North Texas, Mexia, Powell, Richland, Wortham, Lytton Springs, Currie, Moran and Nocona crudes all in Texas.)

March 14, same schedule as Prairie in above fields.

Mirando, Tex.....$1.00

Magnolia Petroleum Co.

(In Oklahoma, Kansas and North and East Central Texas)

Effective Sept. 14, Magnolia posted same price schedule as Prairie in above fields except that Magnolia is paying $1.05 for all oil below 30 gravity.

Corsicana heavy.....$1.00

Carter Oil Co.

(Oklahoma and Kansas)

March 14, same schedule as Prairie.

PANHANDLE, TEXAS

Humble Oil & Refining Co.

Effective Aug. 23

Hutchinson, Carson and Wheeler Counties..$0.75

Pampa, Gray County, Effective March 14:

28-28.9	$ .80	37-37.9	$ .98
29-29.9	.82	38-38.9	1.00
30-30.9	.84	39-39.9	1.02
31-31.9	.86	40-40.9	1.04
32-32.9	.88	41-41.9	1.06
33-33.9	.90	42-42.9	1.08
34-34.9	.92	43-43.9	1.10
35-35.9	.94	44 and above	1.12
36-36.9	.96		

WEST TEXAS

Humble Oil & Refining Co.

Effective Aug. 23

Crane, Upton, Crockett and Pecos Counties...$0.60

NORTH LOUISIANA — ARKANSAS FIELDS

***Prices of Standard Oil Co. of Louisiana Caddo, Homer, Haynesville, Bull Bayou, El Dorado, Crichton and De Soto**

Effective March 14, 1927

Below 28	$1.10	40-40.9	$1.36
28-28.9	1.12	41-41.9	1.38
29-29.9	1.14	42-42.9	1.40
30-30.9	1.16	43-43.9	1.42
31-31.9	1.18	44-44.9	1.44
32-32.9	1.20	45-45.9	1.46
33-33.9	1.22	46-46.9	1.48
34-34.9	1.24	47-47.9	1.50
35-35.9	1.26	48-48.9	1.52
36-36.9	1.28	49-49.9	1.54
37-37.9	1.30	50-50.9	1.56
38-38.9	1.32	51-51.9	1.58
39-39.9	1.34	52 and above	1.60

Smackover, below 24	*$1.00
do 24 and above	* 1.25
Bellevue	1.25
Cotton Valley	1.00
**Urania, La	.90
†East El Dorado	1.00

**Posted by Louisiana Oil Refining Corp.

†Posted by Magnolia Petroleum Co.

*Met on July 6 by Atlantic Oil Producing, and Shreveport — El Dorado Pipe Line Co. Louisiana Oil Refining posted 90c for Smackover below 24, and $1.15 for 24 and above, Sept. 17.

STEPHENS, ARKANSAS

Atlantic Oil Producing Co. and Louisiana Oil Refining Corp.

Below 28	$1.00	30-30.9	$1.06
28-28.9	1.02	31-31.9	1.08
29-29.9	1.04	32 and above	1.10

GULF COASTAL

Posted by Humble Oil & Refining Co.

Effective March 14

Grades A	$1.20	29-29.9	$1.25
Grades B:		30-30.9	1.27
Below 25	1.15	31-31.9	1.29
25-25.9	1.17	32-32.9	1.31
26-26.9	1.19	33-33.9	1.33
27-27.9	1.21	34-34.9	1.35
28-28.9	1.23	35 and above	1.37

' Fields classified as A and B are Spindletop, Goose Creek, Hull, Liberty, Sour Lake, West Columbia, Orange, Boling and Pierce Junction. All other fields are Grades A only.

California Fuel Prices Firmer; Gasoline Unchanged

Staff Special

LOS ANGELES, Sept. 17

MAJOR companies are firmer than ever in California markets and they want 90 cents a barrel for their fuel oil in bulk for export. Two smaller companies are reported to have offered some of this product at 80 cents. These prices are against a price of 70 cents asked last month, before tanker rates declined. One Independent during the week offered 25,000 barrels of fuel oil at 65 cents, but the fuel is not so placed that it could be conveniently moved to tidewater. Fuel oil in tank cars for movement to adjoining states can still be purchased at 65 cents, a price that has ruled for several weeks.

The fuel oil situation, apparently, is in good shape, although stocks have increased during the past year. It is reported this week that one of the larger major companies is asking $1 flat for fuel on spot cargoes.

There has been no change in gasoline prices, both to the reseller and for export. The major companies are asking 6 cents and up for their export spot gasoline and price in tank cars for shipment to points within the state continues at one cent under the tank wagon price, which includes tax.

Independents are selling their gasoline to resellers at 2 cents under the price asked by the majors. But no reseller who handles this gasoline at 2 cents under the posted price is handling any product other than lubricants from the majors.

Gasoline for shipment to points outside the state, which is without tax, can be purchased at 7¼ cents, but practically no gasoline is available for this trade at 7 cents, an advance of a quarter in the past three weeks.

All other products are without change.

* * *

LOS ANGELES, Sept. 16.—Total of 1,610,992 barrels of petroleum products, or a daily average of 230,142 barrels, moved out of Los Angeles harbor week ended Sept. 10 to points outside Pacific coast trade territory. This compares with total of 1,277,433 barrels, the previous week, or a daily average of 182,490 barrels. The movement last week by districts:

Pacific foreign—44,179 barrels crude, 225,857 barrels fuel, 24,898 barrels gasoline, 80,850 barrels Diesel.

Atlantic domestic—70,873 barrels fuel, 225,588 barrels fuel, 269,588 barrels gasoline, 148,149 barrels gas oil.

Atlantic foreign—305,926 barrels fuel, 215,084 barrels gasoline.

Total fuel moved was 757,371 barrels and 509,570 barrels of gasoline was shipped.

Purchasers, in All Fields (in Effect September 19, 1927)

OIL PRICE HANDBOOK published annually)

GULF COASTAL

Prices of The Texas Co.

(Effective March 14)

Grades A	$1.20	*Grades B	$1.15
‡Grades B (light crude):			
35-35.9	$1.37	38-38.9	$1.43
36-36.9	1.39	39-39.9	1.45
37-37.9	1.41	40 and above	1.47

*Grades B include all heavy crudes which do not meet tests for Grades A or for Gulf Coast light crude.

‡The Texas Co.'s gravity and price schedule on oil below 35° is same as Humble's postings on Grades B.

ROCKY MOUNTAIN FIELDS

Prices of Ohio Oil Co. and Midwest Refining Co.

(Salt Creek prices effective March 12)

‡Salt Creek 29-29.9	$1.14
" " 30-30.9	1.16
" " 31-31.9	1.18
" " 32-32.9	1.20
" " 33-33.9	1.22
" " 34-34.9	1.24
" " 35-35.9	1.26
" " 36-36.9	1.28
" " 37 and above	1.30
Elk Basin	1.33
Grass Creek light	1.33
Big Muddy	$1.25
Lance Creek	1.33
Rock Creek	1.25
Mule Creek	1.30
Rex Lake	1.10
‡Osage	1.33
‡Cat Creek, Mont.	1.33
Sunburst, Mont.	1.35
‡Hogback, N. Mex.	1.38
Artesia, N. Mex.	1.00

‡Posted by Midwest Refining Co. Midwest also buys Grass Creek light and Elk Basin.

The Texas Co. buys Salt Creek and Big Muddy crude.

CALIFORNIA

Standard Oil Co. of California

Santa Maria and Ventura Posted by Union Oil Co.

Gravity	Signal Hill Seal Beach Huntington Beach	Inglewood Torrance	Whittier La Habra	Newhall, McKittrick, Kern River	*Ollinda-Brea Canon, Richfield	Athens-Rosecrans Dominguez	Montebello	Coyote Hills	Santa Fe Springs	Midway Sunset Buena Vista & Elk Hills	Lost Hills	Coalinga	Wheeler Ridge	Santa Maria	Ventura
14-14.9	$ .85	$ .85	$ .85	$ .75	$ .85	....	$ .85	$ .85	....	$ .75	$ .75	$ .75	$ .75	$ .85	$ .85
15-15.9	.85	.85	.85	.75	.85	....	.85	.85	....	.75	.75	.75	.75	.85	.85
16-16.9	.85	.85	.85	.75	.85	....	.85	.85	....	.75	.75	.75	.75	.85	.85
17-17.9	.85	.85	.85	.75	.85	....	.85	.85	....	.75	.75	.75	.75	.85	.85
18-18.9	.85	.85	.85	.75	.85	....	.85	.85	....	.75	.75	.75	.75	.85	.85
19-19.9	.85	.85	.85	.75	.85	....	.85	.85	....	.75	.75	.75	.75	.85	.85
20-20.9	.85	.85	.85	....	.85	....	.85	.85	....	.77	.77	.76	.78	.85	.85
21-21.9	.86	.86	.85	....	.86	....	.85	.86	....	.79	.79	.77	.81	.85	.85
22-22.9	.87	.87	.85	....	.87	....	.85	.87	....	.81	.81	.78	.85	.85	.85
23-23.9	.88	.88	....	....	.88	....	.85	.88	....	.83	.83	.79	.89	.85	.85
24-24.9	.89	.89	....	....	.89	$ .89	.85	.89	.85	$ .85	.85	.80	.93	.85	.85
25-25.9	.90	.90	....	....	.90	.90	.86	.90	.85	.87	.87	.81	.97	.86	.86
26-26.9	.92	.92	....	....	.92	.92	.87	.91	.85	.89	.89	.83	1.01	.87	.87
27-27.9	.94	.94	....	....	.94	.94	.88	.92	.85	.91	.91	.85	1.05	.88	.88
28-28.9	.96	.96	....	....	.96	.96	.89	.93	.86	.93	.93	.87	....	.89	.89
29-29.9	.98	....	....	....	.98	.98	.90	.94	.87	.96	.96	.89	....	.91	.91
30-30.9	1.00	....	....	....	1.00	1.00	.91	.95	.88	.99	.99	.91	....	.93	.93
31-31.9	1.03	....	....	....	....	1.03	....	....	.89	1.02	1.02	.93	....	....	.95
32-32.9	1.06	....	....	....	....	1.06	....	....	.91	1.05	1.05	.95	....	....	.97
33-33.9	....	....	....	....	....	1.09	....	....	.93	1.08	1.08	.97	....	....	.99
34-34.9	....	....	....	....	....	1.12	....	....	.95	....	1.11	.99	....	....	1.01
35-35.9	....	....	....	....	....	1.15	....	....	.97	....	....	1.01	....	....	1.03
36-36.9	....	....	....	....	....	1.18	....	....	.99	....	....	....	....	....	1.06
37-37.9	....	....	....	....	....	1.21	....	....	1.01	....	....	....	....	....	1.09
38-38.9	....	....	....	....	....	1.24	....	....	1.03	....	....	....	....	....	1.12
39-39.9	....	....	....	....	....	1.27	....	....	1.06	....	....	....	....	....	1.15
40-40.9	....	....	....	....	....	1.30	....	....	1.09	....	....	....	....	....	....
41-41.9	....	....	....	....	....	1.33	....	....	1.12	....	....	....	....	....	....
42-42.9	....	....	....	....	....	1.36	....	....	1.15	....	....	....	....	....	....

*Union Oil Co. also purchases Long Beach Crude and is maintaining the same gravity and price schedule in that field as the Standard maintains in Signal Hill and Huntington Beach fields. The Union also buys and pays the same prices as the Standard in the Rosecrans-Dominguez fields, on gravities ranging from 14 degrees to and including 24.9 degrees and in Santa Fe Springs, on gravities ranging from 20 to and including 23.9 degrees.

Crude Price Changes

Sept. 14.—Magnolia Petroleum Co. advanced its prices of Oklahoma, Kansas, north and east central Texas crude testing above 30 gravity in amounts ranging from 11 to 15 cents per barrel, which makes its price schedule for oil above 30 degrees the same as that posted on Mid-Continent crude by Prairie on March 12. Oil below 30 degrees is unchanged at $1.05. 30-30.9 gravity is $1.16, with 2 cent differential for each succeeding degree of gravity, up to maximum grade of 52 and above, which is $1.60.

Sept. 14.—Humble Oil & Refining Co. placed Lytton Springs crude, which it reduced on Sept. 1 to conform with Magnolia's May 5 schedule on Mid-Continent crude, back on the same schedule with other north Texas crudes. This amounts to an advance of 15 cents on oil above 33 gravity, and an advance of 7 to 15 cents on oil below 33 gravity. Prices on Lytton Springs are again the same as on Ranger, North Texas, Mexia, etc.

Sept. 14.—Louisiana Oil Refining Corp. reduced Urania, La. crude 10 cents, making new price 90 cents per barrel.

Sept. 17.—Louisiana Oil Refining Corp. reduced Smackover crude 10 cents, making below 24 gravity, 90 cents, and 24 and above, $1.15. The Standard of Louisiana has not yet met this reduction.

* * *

SHREVEPORT, Sept. 20.—On Sept. 20 Standard Oil Co. of Louisiana, Shreveport-El Dorado Pipe Line Co., and Atlantic Oil Producing Co. met the 10 cent reduction posted on Sept. 17 by the Louisiana Oil Refining Corp. on Smackover crude.

New prices are: below 24 gravity, 90 cents; 24 and above, $1.15. Last previous change by the Standard was a re-grading and cut on March 17.

Less Fuel Oil Used In Electricity

WASHINGTON—Of the 73,791,000,000 kilowatt-hours of electricity produced at public utility power plants in 1926, 47,500,000,000 kilowatt-hours, or 64.5 per cent, were generated by fuels and the remainder by water power, according to the U. S. Geological Survey.

Ten per cent of the fuel-power output was generated by fuel oil, gas and wood, and 90 per cent was generated by coal. The use of fuel oil for this purpose has declined since 1924 when it reached its maximum, and less was used in 1926 than in any other year since 1918. In 1926, the amount of fuel oil consumed by public-utility plants was only 57 per cent of that used in 1924.

The average rates of consumption of the various kinds of fuel in generating electricity in this country were: coal, 1.94 pounds per kilowatt-hour; oil, 243 kilowatt-hours per barrel; gas, 22 cubic feet per kilowatt-hour.

Standard Oil Dividends are Less Than 5% on Total Investments

CLEVELAND, Sept. 19

DIVIDENDS of the companies of the Standard Oil group total $47,709,957 in the third quarter. This sum while less than the second quarter payments, was the largest third quarter since the dissolution.

So far this year the Standard companies have paid stockholders $157,874,985. The invested capital of the Standard group totaled $3,897,513,734 Dec. 31 exclusive of the Imperial Oil, Ltd., and the International Petroleum Co., which are Standard of New Jersey controlled but have large minority holdings. No financial statements of these two companies are available. This total included the outstanding common and preferred stocks at par value, borrowed funds, and reinvested surplus.

Excluding from the dividends paid in the first three quarters the disbursements of the Imperial and International, the payments by the group were 3.77 per cent of the total invested monies of the Standard group. This was at an annual rate of 4.96 per cent. Inclusion of the Imperial and International probably would not raise this percentage above 5.

Concerning the Standard group's third quarter payments Carl H. Pforzheimer & Co., New York, specialist in Standard Oil issues, has this to say:

"Standard Oil dividends to be paid in the third quarter of 1927 will establish a new high record for payments in this period of the year at $47,709,957. All companies of the group have already declared dividends for the third quarter with the exception of Prairie Pipe Line Company and the dividend payment of this company is estimated at the usual rate of $2 a share and included in the forgoing figure. Standard of New Jersey, as usual, is the largest dividend payer, disbursing $9,054,457 during the quarter. Standard of Indiana ranks second with $7,994,541; Standard of California third with $7,871,311 and Standard of New York fourth with $6,723,972. Third quarter payments represent a gain of $1,266,679 over the third quarter of 1926 brought about principally by higher dividend disbursements made by Standard of California, Imperial Oil and Prairie Pipe Line companies.

"Each quarterly payment this year has exceeded the corresponding quarter of last year and the total dividends for the first three quarters of the year will amount to $157,874,985 compared with $137,642,046 last year. In the first three quarters of this year Standard of California had disbursed approximately $25,000,000 in dividends to stockholders compared with $17,300,000 paid in the same period of 1926. Standard Oil of New York disbursed approximately $3,000,000 more in dividends to stockholders in the first three quarters of this year over last year and Imperial Oil, Ltd., has increased its dividend disbursements $2,400,000 so far this year.

"The retirement of the preferred stock of Standard of New Jersey in the first quarter of this year resulted in the omission of a quarterly payment of $3,500,000 in the second and third quarters of 1927 but with the increase of the outstanding common capitalization and a higher dividend rate, the company has disbursed approximately $3,400,000 more in cash dividends to stockholders this year. Prairie Pipe Line increased its dividend payments $1,200,000 so far in 1927 while the Humble Oil & Refining Co. added over $1,000,000 to cash disbursements in the first three quarters of this year. Payments for the third quarter of 1927 are $6,581,658 less than the second quarter because

Dividend Payments of Standard Group in 13 Years

	First Quar.	Second Quar.	Third Quar.	Fourth Quar.	Totals
1927	$55,873,413	$54,291,615	$47,709,957		
1926	40,580,317	‡50,618,451	46,443,278	$62,685,548	$200,327,594
1925	34,355,618	41,905,728	35,140,584	42,104,169	153,506,099
1924	34,975,867	40,699,592	34,712,810	40,000,286	150,388,555
1923	33,499,988	36,311,251	31,066,251	37,545,805	138,423,295
1922	28,206,068	29,205,349	28,628,099	*43,000,349	129,039,865
1921	28,987,611	29,131,727	27,609,227	29,586,727	115,294,292
1920	26,796,606	27,313,396	29,804,557	31,861,824	115,776,793
1919	26,759,502	26,397,119	24,418,169	28,326,687	105,901,477
1918	26,483,747	26,759,002	26,204,915	24,035,252	103,480,916
1917	23,097,668	26,428,252	22,968,751	27,463,252	99,957,923
1916	22,179,085	†30,406,454	21,980,168	24,062,168	98,627,875
1915	15,241,966	14,368,636	15,891,966	16,898,636	62,401,204

* Includes aggregate extra disbursements of $11,600,000 by four eastern pipe line companies.
† Includes $6,613,786 disbursed by National Transit Co. in adjustment of capitalization.
‡ Includes $4,000,000 paid by Southern Pipe Line Co. in reducing par value.

Total Invested Money of Standard Oil Group

COMPANY	Common Stock	Preferred Stock	Funded Debt Dec. 31, 1926	Surplus Dec. 31, 1926
*Anglo American	$19,499,964	.....	$6,015,454	$10,401,721
Atlantic Refining	50,000,000	$20,000,000	17,554,950	33,719,960
Borne Scrymser	1,000,000	.....	.....	568,937
Buckeye Pipe Line	10,000,000	.....	.....	3,238,717
†Chesebrough Mfg	3,000,000	.....	.....	855,662
Continental Oil	35,805,260	.....	1,436,700	33,093,029
Cumberland Pipe Line	3,000,000	.....	.....	1,581,151
Eureka Pipe Line	5,000,000	.....	.....	2,613,512
Galena Signal Oil	16,000,000	6,000,000	6,692,900	1,534,483
Humble Oil & Refg	73,117,577	.....	27,350,198	61,943,790
Illinois Pipe Line	20,000,000	.....	.....	6,406,743
Indiana Pipe Line	5,000,000	.....	.....	2,458,664
National Transit	6,362,500	.....	.....	4,797,439
New York Transit	5,000,000	.....	.....	1,343,572
Northern Pipe Line	4,000,000	.....	.....	234,773
Ohio Oil	60,000,000	.....	267,000	41,045,431
Prairie Oil & Gas	60,157,300	.....	.....	90,962,163
Prairie Pipe Line	81,000,000	.....	.....	31,955,936
Solar Refining	4,000,000	.....	.....	1,241,967
Southern Pipe Line	5,000,000	.....	.....	432,945
South Penn Oil	20,000,000	.....	.....	25,994,746
S. W. Penn Pipe Lines	3,500,000	.....	.....	487,598
Standard of California	314,852,450	.....	2,788,393	228,845,178
Standard of Indiana	228,415,463	.....	.....	108,307,075
Standard of Kansas	8,000,000	.....	.....	636,937
Standard of Kentucky	17,012,559	.....	.....	15,858,319
Standard of Nebraska	4,559,850	.....	.....	2,040,016
Standard of New Jersey	517,397,550	‡199,972,900	120,000,000	346,367,375
Standard of New York	420,248,275	.....	114,172,500	94,651,701
Standard of Ohio	14,000,000	7,000,000	.....	20,927,139
Swan & Finch	861,466	150,500	.....	416,569
Union Tank Car	30,734,000	.....	13,000,000	2,454,092
Vacuum Oil	62,470,800	.....	.....	68,699,884
Total	$2,108,995,014	$233,123,400	$309,278,096	$1,246,117,224
Total money invested, Dec. 31, 1926				$3,897,513,734

* Pounds sterling converted to dollars at par.
† Dec. 31, 1925, last available financial statement.

Transactions in Oil Shares on New York Stock Exchange

1926 High	1926 Low	1927 High	1927 Low		Listed Capital	Par Value	Stocks	Div. Rate	Last Paid	Transactions Week Ended Sept. 17 Sales	First	High	Low	Last	Change
32⅛	24½	37⅝	27⅝	(sh)	915,675	N.P.	Amerada Corp.	50cQ	July 30, 27	4,000	29¾	30	29½	29½	0
74	39⅞	64⅛	35⅛	(sh)	209,180	N.P.	American Republics	.....	.....	11,100	47	52½	47	47	+ 1
59½	44¾	50¼	42	$	56,000,000	$25	Associated Oil	50cQ	Sept. 24, 27	.....	.....	.....	.....	.....	.....
128¾	97	131⅜	107		50,000,000	100	Atlantic Refining	$1Q	Sept. 15, 27	14,400	121¾	123	117¾	118	— 3¼
120	115½	118	115½		20,000,000	100	do pfd	$1.75Q	Aug. 1, 27	100	117¼	117¼	117¼	117¼	— 1¾
33½	23½	35½	20⅞		25,000,000	25	Barnsdall Corp. A	62½cQ	July 15, 27	33,400	23	23⅜	22	23	— ⅜
29½	22½	32½	21¼		3,840,275	25	do B	62½cQ	July 15, 27	1,000	23	23	22⅜	22½	+ ⅛
68⅛	29¾	32⅞	21⅜		49,505,175	25	California Petroleum	25cQ	Sept. 1, 27	7,200	23¼	23⅜	22	22	— 1⅛
94¼	50	96¾	65		24,242,500	100	General Asphalt	.....	.....	21,000	74	75½	72½	72⅝	— 1⅜
140½	94⅞	144⅞	107¼		6,949,200	100	do pfd	$1.25Q	Sept. 1, 27	.....	.....	.....	.....	.....	.....
72	50¼	174⅛	60⅛		25,000,000	100	Houston Oil	.....	.....	208,600	154	155½	143¼	145	— 7
84	19⅜	32¼	17⅛	(sh)	500,000	N.P.	Independent Oil & Gas	25cQ	July 18, 27	4,400	20¼	21	20¼	21	+ ¾
13¾	7¼	11¾	7½	$	3,280,340	$10	Indian Refining	.....	Dec. 15, 20	8,700	11½	*11¾	10½	10½	— ⅞
12½	8	11¾	7¼		4,550,110	10	do ctfs	.....	.....	5,500	10⅞	*11¾	10½	10½	— ½
104	90	112	99⅜		2,296,400	100	do pfd	.....	Dec. 15, 21	200	110	110	110	110	0
24⅛	19⅛	32½	20½	(sh)	3,988,044	N.P.	Lago Oil & Transport	75cQ	Aug. 1, 27	8,300	31½	31⅞	31	31½	+ ¼
19¾	12	18⅞	10½	(sh)	1,135,662	N.P.	Louisiana Oil Refining	.....	.....	6,000	11¼	11½	10⅞	10⅞	— ¼
98	93	97	90	$	4,000,000	$100	do pfd	$1½Q	Aug. 15, 27	30	90½	90½	90½	90½	— ½
28⅞	16½	22¾	13	(sh)	330,000	N.P.	Maracaibo Oil	.....	.....	200	14¼	14¾	14¼	14¾	— ½
63¾	49¾	58½	31	(sh)	2,308,064	N.P.	Marland Oil Co.	.....	Mar. 31, 27	64,900	37	37¼	34⅝	35	— 1⅜
250	225	250	200	$	45,942,800	$100	Mexican Petroleum	$3Q	July 20, 27	.....	....	....	....	....	.....
....	....	....	....		12,000,000	100	do pfd	$2Q	July 20, 27	.....	....	....	....	....	.....
13¾	6	9¼	3	(sh)	945,939	N.P.	Mexican Seaboard	.....	Nov. 15, 24	2,900	4	4⅛	3⅜	3⅜	— ⅛
37	27½	39⅜	29	(sh)	1,357,800	N.P.	Mid-Continent Petroleum	75cQ	Aug. 1, 27	38,600	30½	33⅝	30¼	33⅛	+ 2⅝
104¼	90	105	97	$	6,718,000	$100	do pfd	$1.75Q	Sept. 1, 27	100	104	104	104	104	+ 1
2½	⅜	3⅜	1⅜		24,726,130	10	Middle States	.....	July 1, 23	10,800	2½	2⅝	2⅜	2⅜	— ⅛
1⅜	½	2¾	1⅛		5,074,090	...	do ctfs	.....	.....	2,400	2	2	1¾	1¾	— ¼
2¼	1	1⅞	1	(sh)	3,500,000	N.P.	Pacific Oil	.....	.....	600	1⅛	1¼	1⅛	1¼	+ ⅛
76½	56⅛	65⅞	45⅛	$	48,307,400	$ 50	Pan American P. & T.	$1.50Q	July 20, 27	6,800	49¼	53½	49⅛	49⅞	+ ⅝
78¾	56⅞	66¾	45⅝		121,096,950	50	do B	$1.50Q	July 20, 27	90,300	49⅞	53¼	49	50¾	+ 1¼
46	30	37⅞	19	(sh)	400,000	N.P.	Pan American Western B	.....	Jan. 30, 27	1,400	20⅛	21	20	20	+ ⅛
62	4½	18⅞	8	(sh)	198,770	N.P.	Panhandle P. & R.	.....	.....	10,500	9¾	11¾	9¾	11⅛	+ 2⅛
99⅛	51	83¾	58¾	$	2,935,200	$100	do pfd	.....	July 2, 23	100	55¼	59¼	55¼	59¼	+ 5¼
57⅝	40	60¼	38	(sh)	2,406,796	N.P.	Phillips Petroleum	75cQ	July 1, 27	60,600	43¾	44⅝	41⅝	41¾	— 2
1⅜	⅛	1⅜	⅛	$	29,622,925	$ 25	Pierce Oil Corp.	.....	.....	300	....	⅜	⅛	⅜	0
27⅛	11⅛	24	13½		15,000,000	100	do pfd	.....	Feb. 1, 22	.....	.....	.....	.....	.....	.....
7	2¼	5½	2½	(sh)	2,500,000	N.P.	Pierce Petroleum	.....	.....	26,500	3⅜	4	3½	4⅝	0
20¾	11	33⅞	16¾	$	11,467,850	$50	Producers & Refiners	.....	Sept. 15, 23	10,900	25⅜	26¼	24¼	24¼	— 1¼
41¾	30¾	50	36⅞		2,845,350	50	do pfd	.....	May 1, 25	10	43	44	43½	43⅞	+ 1⅞
31	25¼	33⅛	25⅝		75,929,250	25	Pure Oil Co.	‡37½cQ	Sept. 1, 27	21,700	26⅛	27⅜	26⅛	26½	+ ¼
112¾	106	114	111⅜		13,000,000	100	do 8% pfd	$2Q	July 1, 27	.....	.....	.....	.....	.....	.....
57⅜	47⅜	58	45¼	(sh)	628,559	13.40	Royal Dutch, N. Y. shares	$1.80	Aug. 2, 27	2,600	46¾	46⅞	46	46¼	— ¾
40⅜	40½	47⅞	42⅛	(sh)	83,152	F2	Shell Transport & T	$1.45	July 22, 27	.....	.....	.....	.....	.....	.....
31	24	31¾	25	(sh)	10,000,000	N.P.	Shell Union Oil	35cQ	June 30, 27	10,800	26¾	26⅞	25¼	25¼	— 1¼
114	103	111	107½	$	18,350,400	$100	do pfd	$1½Q	Aug. 15, 27	.....	.....	.....	.....	.....	.....
28⅝	15½	22¾	14¼		7,208,080	10	Simms Petroleum	.....	Apr. 1, 27	5,000	15¾	17	15¾	16¾	+ 1
24⅞	16¾	22⅜	16	(sh)	4,501,224	N.P.	Sinclair Consolidated	.....	May 31, 24	89,500	17¼	18¼	17	17	— ⅛
99½	90	103¼	97	$	17,210,000	$100	do pfd	$2Q	Aug. 15, 27	600	99½	100	99½	100	+ ⅜
37½	26⅝	37⅝	24½		27,398,500	25	Skelly Oil Co.	50cQ	Sept. 15, 27	5,000	26⅞	27⅜	26	26¼	— ⅜
63¾	52⅝	60¾	50⅜	(sh)	13,016,434	N.P.	S. O. California	62½cQ	Sept. 15, 27	18,100	55	55	53¼	53½	— 1
46¾	37⅜	43¾	35⅛	$	604,484,600	$25	S. O. New Jersey	‡25cQ	Sept. 15, 27	109,400	40½	*43¾	39½	39¾	0
33¾	32½	34⅛	29¾		421,498,275	25	S. O. New York	40cQ	Sept. 15, 27	31,900	31⅞	31⅞	31¼	31½	+ ¼
41⅜	30½	34⅞	30	(sh)	1,171,474	N.P.	Sun Oil	25cQ	Sept. 15, 27	1,600	32	32	31¼	31¾	— ¼
....	....	100	99	$	6,000,000	$100	do. pfd.	$1.50Q	Sept. 1, 27	400	99	100	99	100	+ 1
5¾	1	6⅛	3¾	(sh)	1,121,368	N.P.	Superior Oil Corp.	.....	Dec. 20, 20	2,300	3¾	3⅞	3¾	3¾	0
57⅞	53⅛	58	45	$	179,752,525	25	The Texas Corp.	75cQ	July 1, 27	38,000	50½	51	49¾	50⅛	— ⅜
19½	12	18⅞	12		8,380,340	10	Texas Pacific Coal & Oil	.....	Mar. 31, 27	15,800	13⅞	15	13⅞	14⅝	+ 1
39¼	37	29½	22	(sh)	2,157,991	N.P.	Tide Water Oil Co.	20cQ	June 30, 27	.....	.....	.....	.....	.....	.....
103	87¼	89¾	86	$	20,705,100	$100	do 5% pfd.	$1.25Q	Aug. 15, 27	700	89	90⅛	88½	88½	— ⅛
....	....	19½	15½	(sh)	4,791,410	N.P.	Tide Water Associated	15cQ	Aug. 1, 27	20,800	16¾	16⅞	16	16½	— ¼
....	....	90¾	86½	$	76,347,100	$100	do pfd. new	$1.50Q	July 1, 27	600	86½	86¾	†86⅛	86½	— ½
5½	3	9¾	3¾	(sh)	3,742,029	N.P.	Transcontinental Oil	.....	.....	40,500	8	8¼	7¾	7¾	— ¼
58¾	37¼	56½	39⅝	$	40,741,725	$ 25	Union Oil of California	50cQ	Aug. 10, 27	9,000	43	43¾	42¼	42¼	— 1
120⅜	84¼	116½	94		30,734,000	100	Union Tank Car Co.	$1.25Q	Sept. 1, 27	200	111½	111½	111¼	111¼	+ ¼
....	....	28½	24½	(sh)	239,860	N.P.	Warner Quinlan	50cQ	July 2, 27	200	....	25½	25⅜	25½	+ ¼
29¾	25⅛	27½	22	(sh)	490,000	N.P.	White Eagle Oil & Refining	50cQ	July 20, 27	800	22½	23¼	22⅛	22⅛	— ½

•New High †New Low xEx-Dividend ‡Also extras Total Sales 1,087,340

PITTSBURGH STOCK EXCHANGE

1926 High	1926 Low	1927 High	1927 Low	Par Value	Stocks	Transactions Week Ended Sept. 16 Sales	First	High	Low	Last	Ch'ge
8½	5¾	9½	6⅜	$ 10	Arkansas Nat. Gas..	1,520	9	9	x8⅞	9	— ¼
90½	79¾	98⅝	84	100	Columbia Gas.....	.....	....	....	....	....	.....
101¾	95	107	100	100	do pfd.....	.....	....	....	....	....	.....
17	12½	15	9½	10	Devonian Oil.....	100	9½	9½	9½	9½	0
116½	112	116¾	115	100	Duquesne Lt. 7% pfd.	100	115¾	115¾	115¾	115¾	— ¾
10	5⅛	12¾	6	N.P.	Houston Gulf Gas..	100	9¼	9¼	9¼	9¼	— ¼
46	39	49½	37¼	$ 25	Lone Star Gas.....	3,967	48¾	48¾	48⅛	48⅜	— ⅜
47⅛	33⅛	22¾	22¼	25	Ohio Fuel Corp.....	.....	....	....	....	....	.....
47½	42	21¾	21	....	do ctfs.....	.....	....	....	....	....	.....
6¾	5	6	5	....	Ohio Oil & Gas.....	.....	....	....	....	....	.....
34	21	21	21	25	Oklahoma Nat. Gas.	.....	....	....	....	....	.....
21	19¼	23¾	20¾	....	do ctfs.....	565	21½	21½	21¼	21½	0
5⅛	3¼	3¼	3	5	Pittsburgh Oil & Gas	30	3¼	3¼	3¼	3¼	0
10	7½	8	6	10	Salt Creek Cons.....	70	6¼	6¼	6¼	6¼	— ½
27	8	26½	17	10	Tidal Osage.....	.....	....	....	....	....	.....
45	40	43	40	N.P.	Waverly Oil Wks. "A"	135	40	40	†40	40	0

PITTSBURGH CURB EXCHANGE

1926 High	1926 Low	1927 High	1927 Low	Par Value	Stocks	Transactions Week Ended Sept. 16 Sales	First	High	Low	Last	Ch'ge
3⅜	2½	3½	2¾	$ 5	Columbia Synd.....	.....	....	....	....	....	.....
20	.06	.18	.18	5	Duquesne Oil.....	.....	....	....	....	....	.....
91½	85	94	88	25	Gulf Oil Corp.....	.....	....	....	....	....	.....
79	79	105	93	100	Houston Gulf Gas pfd	.....	....	....	....	....	.....
12	7⅛	10¾	6¼	N.P.	Leonard Oil & Dev...	1,200	9	9⅛	9	9	0
30¼	29	32	31¼	$ 25	Oklahoma Gas.....	.....	....	....	....	....	.....
2	.15	2.70	.75	10	Omar Oil & Gas.....	2,700	1.00	1.00	.90	.90	— .10
....	....	2¼	1¾	....	Pittsburgh Oil Dev...	.....	....	....	....	....	.....
2	1¾	2¼	2¼	5	do pfd.....	.....	....	....	....	....	.....
33½	20	31	21¾	10	Plymouth Oil.....	100	21¾	21¾	†21¾	21¾	— 2¼
7	3	6	5	5	States Oil.....	.....	....	....	....	....	.....
3½	2	3⅛	1¾	1	Texon Oil & Land...	100	2	2	2	2	0
25¾	8	23¾	18	10	TidalOsage(non-vtg).	.....	....	....	....	....	.....

•New high †New Low xEx-Dividend

Cleveland Stock Market

September 16

	Par Value	Bid	Asked	Last Sale
Canfield Oil Co.	100	...	...	100
do pfd	100	100	...	100
Fred G. Clark Co.	10	...	3	3½
National Refining Co.	25	35¼	35¼	35¼
do pfd	100	x128	...	130
Paragon Refining Co.	25	7½	8⅞	8½
do pfd	100	84	...	81

x Ex Dividend

Oil Dividends

	Amount	Stock of Record Payable	Record
Barnsdall A & B q.	62½c	Nov. 1	Sept. 26
Gulf Oil q.	37½c	Oct. 1	Sept. 20
Lone Star Gas q.	50c	Sept. 30	Sept. 20
Mountain & Gulf q.	2%	Oct. 15	Sept. 30
do extra	1%	Oct. 15	Sept. 30
New England Fuel q.	25c	Oct. 1	Sept. 17
Washington Oil q.	$1	Sept. 20	Sept. 14
West Coast Oil pfd. q.	$1.50	Oct. 5	Sept. 24
do extra	$3	Oct. 5	Sept. 24

Standard Oil Stock Traded in New York

1926 High	1926 Low	1927 High	1927 Low	Outstanding Capital	Par Value	Stocks	Div. Rate	Last Paid	Transactions Sales	Week Ended Sept. 17 First	High	Low	Last	Change
21	16⅜	21⅝	17⅝	£ 4,000,000	£1	Anglo-American Oil	60 11/16c	May 31, 27	1,900	18¾	18¾	18¼	18¼	— ½
20¼	16½	20½	17⅝	.....	£1	do ctfs. non-voting	.....	.....	100	18	18	18	18	— ⅛
2¼	.75	1⅜	.75	(sh) 500,000	N.P.	Atlantic Lobos	.....	.....	400	1⅛	*1⅜	1⅛	1⅜	+ ⅛
5	2⅞	4¼	2½	$ 10,000,000	$ 10	do pfd.	.....	.....	.....	.....	.....	.....	.....	.....
75	65	69	50	1,000,000	25	Borne Scrymser	‡$1S.A.	Apr. 15, 27	100	62¼	62¼	61	61	— 1½
59½	42	59	45	10,000,000	50	Buckeye Pipe Line	$1Q	Sept. 15, 27	2,600	55½	57	55½	57	+ 1
82½	65	115	76½	3,000,000	25	Chesebrough Mfg.	$1Q	June 30, 27	200	109	109	109	109	— ½
25⅞	17½	22⅝	16½	38,805,260	10	Continental Oil	25cQ	Sept. 15, 27	9,900	19	19¼	18½	18½	— ½
137	102	137	89	3,000,000	100	Cumberland Pipe Line	$2Q	Sept. 15, 27	100	90	90	90	90	0
63¾	43	58⅛	47	5,000,000	100	Eureka Pipe Line	$1Q	Aug. 1, 27	.....	.....	.....	.....	.....	.....
32½	9⅛	13½	7⅛	16,000,000	100	Galena Signal Oil	.....	June 30, 25	300	8⅛	8⅛	8	8	0
94½	35	59¾	35	4,000,000	100	do new pfd	.....	June 30, 26	10	36	36	36	36	0
97½	40	60⅛	36	2,000,000	100	do old pfd	.....	June 30, 26	70	48½	48½	45	45	+ 2½
99⅝	52	63⅞	54	73,117,577	25	Humble Oil & Refining	‡30cQ	July 1, 27	29,100	61⅞	62⅞	61¼	62¼	— 1⅝
144½	125¼	164¾	123¾	20,000,000	100	Illinois Pipe Line	$6S.A.	June 15, 27	300	162	162	161¾	161¾	+ ¼
39¾	32½	55¾	37¾	(sh) 6,491,952	N.P.	Imperial of Canada	‡25cQ	Sept. 1, 27	9,200	54	54¼	52⅝	53	— ⅜
70	54¼	72½	61	$ 5,000,000	$50	Indiana Pipe Line	$1Q	Aug. 15, 27	500	69½	69½	68¾	68¾	— ⅜
35¼	28¾	34⅞	28	(sh) 7,118,138	N.P.	International Petro'eum	25c	June 15, 27	12,600	31⅞	32	31⅜	31⅜	— ⅝
20¾	12½	17	13½	$ 6,362,500	$12½	National Transit Co	25cQ	June 15, 27	1,100	15⅞	16	15½	15¾	— ⅛
51½	27⅛	37	31¾	5,000,000	100	New York Transit	.....	July 15, 26	.....	.....	.....	.....	.....	.....
80½	64	91	70	4,000,000	100	Northern Pipe Line	$3S.A.	July 1, 27	50	84½	84½	84½	84½	0
67⅝	55¾	64¼	52	60,000,000	25	Ohio Oil Co	‡50cQ	Sept. 15, 27	6,500	61	61⅜	60½	61⅜	+ ⅛
24¾	15	31	12	10,000,000	25	Penn Mex. Fuel	.....	May 21, 25	400	23½	23½	23	23	— ⅜
60¼	48	55½	45⅜	60,000,000	25	Prairie Oil & Gas	50cQ	Aug. 31, 27	3,200	50½	51¼	50⅜	51¼	+ ⅜
137½	122¼	186	132	81,000,000	100	Prairie Pipe Line	$2.50Q	July 31, 27	1,750	181½	185	181½	183½	+ 1
220	184½	201½	180	4,000,000	100	Solar Refining	$5S.A.	June 20, 27	.....	.....	.....	.....	.....	.....
27	21	27¼	15½	5,000,000	50	Southern Pipe Line	.....	Mar. 1, 26	.....	.....	.....	.....	.....	.....
50	34½	41½	34½	20,000,000	25	South Penn Oil	50cQ	June 30, 27	400	38¼	38½	37½	37½	— ¼
57	49	77	55½	3,500,000	100	South West Pa. Pipe Lines	$1Q	July 1, 27	200	68¾	69	68¼	69	— 5
70½	60½	75⅞	64¾	228,415,463	25	S. O. Indiana	‡62½cQ	Sept. 15, 27	33,200	74⅛	74½	72½	73¾	— ½
36½	16½	20⅞	15⅝	8,000,000	25	S. O. Kansas	.....	June 16, 24	100	16⅜	16⅜	16¾	16¾	+ ⅛
134¾	108	123¾	111½	17,012,599	25	S. O. Kentucky	$1Q	June 30, 27	800	123½	123¾	123	123	• — ½
51⅜	42	49½	42	4,559,850	25	S. O. Nebraska	63cQ	Sept. 20, 27	200	45	45	45	45	0
672	288	863¾	73	14,000,000	25	S. O. Ohio	62½cQ	July 1, 27	200	79	79	79	79	— ½
120½	116½	122	117¼	7,000,000	100	do pfd	$1.75Q	Sept. 1, 27	.....	.....	.....	.....	.....	.....
23	15½	18	14½	861,466	25	Swan Finch Co	.....	Nov. 1, 19	200	17½	17½	16¾	16¾	— ⅜
109¾	90¼	134⅝	95⅛	62,470,800	25	Vacuum Oil	‡50cQ	Sept. 20, 27	2,600	128½	128½	127⅛	127¼	— 1⅛

*New high †New low xEx dividend ‡Also extras.

the semi-annual payments of Anglo-American Oil Co. and Illinois Pipe Line Co. and the liquidating dividend of the Crescent Pipe Line Co. were paid in the preceding quarter. The significant feature is that not a reduction in dividends was made by any of the companies in the quarter."

New York Curb Bonds

Week Ending Sept. 17

	High	Low	Last	Ch'ge
Beacon Oil 6s '36	101¼	101	101	— ⅜
Cities Service 5s '66	90¼	89⅜	89⅞	— ⅜
Cities Service 6s '66	101¼	101	101¼	0
Cities Service 5½s '42	94¼	93½	93¾	—1¼
Empire Oil 5½s '42	92⅝	92⅛	92¼	— ⅜
Galena S. O. 7s '30	92	91⅛	91⅜	+ ⅞
General Pet. 6s '28	101¼	101	101	0
Gulf Oil 5s '37	100¾	100	100⅛	0
Gulf Oil 5½s '28	100½	100⅜	100⅜	+ ⅜
Indpen. Oil 6s '39	98½	98½	98½	0
Phillips Pet. 5½s '39	95½	95⅜	95⅜	0
Pure Oil 6½s '33	103⅝	103⅝	103⅝	— ¼
Pure Oil 5½s '37	98¾	98½	98¾	+ ¼
Richfield Oil 6s wi '41	93	92¼	93	+ ¾
Sinclair Oil 6s	99⅛	99	99	0
S. O. N. Y. 6½s '33	104⅞	104½	104⅜	— ⅛
Sun Oil 5½s '39	101½	101	101¼	+ ½
Trans. Cont. Oil 7s '30	115	111¼	114⅛	+2⅝
White Eagle 5½s '57	96½	96	96	— ½

New York Bonds

Week Ending Sept. 16

	High	Low	Last	Ch'ge
Amer. Rep. deb. 6s	99½	99⅛	99½	0
Assoc. Oil gold 6s	103	102½	103	0
Atlantic Refg. deb. 5s	101¾	101⅝	101⅝	— ⅛
Barnsdall Corp. 6s	98⅞	97¾	98	— ¾
Barnsdall Corp. 6s ex war.	90¾	89½	90½	+1
Cal. Petrol. 5s	94	93⅝	94	+ ½
Cal. Petrol 5½s	99	98	99	+ ¼
Empire Gas & Fuel 7½s	110	109⅞	109⅞	— ⅛
Empire Gas & Fuel 6½s	105½	105½	105½	0
Gen. Asphalt 6s	106½	106	106	— ⅝
Gen. Petroleum 5s	101½	101⅜	101½	0
Humble Oil & Refg. 5½s	102¾	102⅜	102½	— ⅛
Humble Oil 5s wi	99⅝	99¼	99⅝	0
Mid-Cont. Pet. 6½s	105¾	105⅛	105¾	+ ⅝
Pan Amer. P & T 7s	105⅜	105⅛	105⅛	— ⅛
Pan Amer. P & T 6s	102½	102⅛	102⅛	— ⅛
Pan Amer. P & T 6s	94¼	93⅞	94	— ¼
Simms Pet. cvt. 6s	99½	99½	99½	0
Sinclair Con Oil col 7s	100¼	99⅞	100¼	+ ⅛
Sinclair Con Oil con 6½s	96	95¾	95¾	— ⅛
Sinclair Con Oil 6s	100⅛	100⅛	100⅜	+ ¼
Sinclair Crude Oil 6s	100⅛	100⅜	100⅜	
Sinclair Pipe line 5s	93½	93	93⅜	— ¼
Skelly Oil 5½s	93⅜	95	95⅛	— ¼
S. O. N. Y. 4½s	96⅛	95⅝	96	— ⅛
S. O. N. J. deb. 5s	103¾	103¼	103⅜	— ⅛
Union Oil of Cal. 6s-A	91	98	98	0
Union Oil of Cal. 5s-C	98½	98	98½	+ ½

New York Curb Market

1926 High	1926 Low	1927 High	1927 Low	Par Value	Stocks	Transactions Sales	Week Ended Sept. 17 First	High	Low	Last	Change
6¾	45	2 7/16	.55	$5	Amer. Con. Oilfields	198,000	.79	1 1/16	.79	1 1/16	+ ½
14½	4	7½	3	N.P.	Amer. Maracaibo	1,200	4	4	3¾	3¾	— ¼
8⅜	5⅜	9¾	6¾	$10	Arkansas Nat. Gas	1,500	9⅛	9⅛	8⅞	9	— ⅛
20⅜	14⅛	20½	15½	N.P.	Beacon Oil	.....	.....	.....	.....	.....	.....
85¼	60	29½	20½	N.P.	British American	400	27½	*29½	27½	29½	+ 2⅛
28⅜	9¼	28¼	14⅜	25c	Carib Syndicate(new)	13,000	23	23⅞	22⅜	23⅜	— ⅛
...	...	26	16½	...	do ctfs. of deposit	.....	.....	.....	.....	.....	.....
51	37½	53¾	40¼	$20	Cities Service	9,000	49⅛	49⅝	49	49¼	0
92½	82⅜	92¼	87	100	do pfd	2,700	90½	90⅝	90	90¼	— ¼
8⅜	7⅜	8½	7⅜	10	do pfd. B	500	8¼	8¼	8¼	8¼	+ ½
25¼	19	29¼	22½	10	do banker's shares	.....	.....	.....	.....	.....	.....
3½	1¾	3 1/16	1¾	$1	Colombia Syndicate	3,300	2 1/16	2⅛	2 1/16	2⅛	0
10⅛	8⅛	9½	7	10	Consolidated Royal	.....	.....	.....	.....	.....	.....
16	10	14⅞	9⅞	N.P.	Creole Syndicate	19,100	10⅞	11½	10⅝	11	0
7⅜	1½	3	1	N.P.	Crown Central	4,700	1	1⅛	1	1⅛	+ ⅛
8½	½	12	4¾	...	Darby Petroleum	.....	.....	.....	.....	.....	.....
...	...	11½	6	...	do trust ctfs.	.....	.....	.....	.....	.....	.....
4	1¾	2½	1¼	N.P.	Derby Oil & Refining	.....	.....	.....	.....	.....	.....
19	13	16¾	10	N.P.	do pfd	.....	.....	.....	.....	.....	.....
7½	2½	3¾	1	N.P.	Gibson Oil	9,400	1⅜	1⅜	1	1¼	+ ¼
2	.63	1⅜	40	N.P.	Gilliland ctfs.	.....	.....	.....	.....	.....	.....
98	82	96½	86¼	$25	Gulf Oil Corp.	6,400	91	92¾	90⅜	91⅞	+ ¾
3⅜	1	2¼	1¼	N.P.	Kirby Petroleum	.....	.....	.....	.....	.....	.....
12¼	5¾	10⅞	6	N.P.	Leonard Oil & Dev.	9,300	9	9¼	9	9⅛	+ ⅛
27	20	27½	21½	N.P.	Lion Oil & Refg.	100	22½	22½	22½	22½	— ⅜
46	31	49½	37	$25	Lone Star Gas	200	48⅝	48⅝	48	48	— ⅜
2¾	2	2⅜	.90	1	Magdalena Synd.	15,900	98	106	†90	95	— 5
5½	1⅞	3	1½	10	Mexican-Panuco	.....	.....	.....	.....	.....	.....
1¾	1¼	1½	1	1	Mountain & Gulf	300	1 1/16	1 1/16	1 1/16	1 1/16	0
26	23	26⅞	22¾	10	Mountain Producers	3,800	24¾	24¾	23½	23¾	— ¾
6¾	5	5⅞	4¾	5	New Bradford	.....	.....	.....	.....	.....	.....
11¾	2	6¼	4	10	New England Fuel	.....	.....	.....	.....	.....	.....
17	9⅛	16	9¼	1	New Mex. & Ariz.	9,000	10¾	11½	10⅛	11½	+ 1¼
17	8	13¼	9	25	New York Oil	300	11⅛	11⅛	11	11	— ⅛
12⅛	8¾	12⅝	10½	N.P.	North Cent. Texas	400	10½	10½	10½	10½	0
44¾	33	...	...	$25	Ohio Fuel Corp.	.....	.....	.....	.....	.....	.....
33	28½	27½	21¼	...	Okla. Nat. Gas ctfs.	.....	.....	.....	.....	.....	.....
10⅛	5⅞	9⅜	1¾	N.P.	Pandem	900	2½	2½	2¼	2¼	— ¼
12¼	11¾	12⅛	9⅝	N.P.	Pantapec Oil	2,300	9¾	10	9¾	10	0
2¾	.20	.37	.25	N.P.	Peer Oil Corp.	.....	.....	.....	.....	.....	.....
22¾	12	13½	6½	$10	Pennok Oil	.....	.....	.....	.....	.....	.....
38	14⅛	24⅜	14½	25	Red Bank Oil	.....	.....	.....	.....	.....	.....
30¼	12	15½	2	N.P.	Reiter-Foster	8,400	4	6	4	5¾	+ 1⅜
27½	22	27½	15	$25	Richfield Oil	100	19	19	19	19	— ⅜
7½	4½	7	4½	N.P.	Ryan Consolidated	480	5¾	6¾	5¾	6½	0
10	7½	8	6	$10	Salt Creek Cons.	400	6½	6½	6½	6½	0
36	26⅞	32	27¼	10	Salt Creek Prod.	2,600	29	29	28¼	28¾	— ½
4⅜	1⅛	7	2⅛	5	Savoy Oil	100	2¼	2¼	2¼	2¼	0
27	7⅝	26½	17	10	Tidal Osage	200	20¼	20¼	20¼	20¼	+ ¼
25¾	7⅝	23¾	15	10	do non-voting	5,100	20	20	19⅝	19⅝	— ⅛
...	...	88	63½	100	Transcontinental pfd.	.....	.....	.....	.....	.....	.....
3	4⅛	7⅜	4¼	5	Venezuelan Petrol.	9,600	5¾	5⅞	5½	5¾	0
31⅛	22	32⅝	20⅜	N.P.	Wilcox Oil & Gas	200	22⅜	22⅜	22¼	22¼	0
9½	4⅜	8	5¼	$1	Woodley Petroleum	300	5¼	5¼	*5¼	5¼	— ⅜

*New High † New Low xEx Dividend

Bonds Issued to Build Dixie Gulf Gas Line

CLEVELAND, Sept. 17.—The Dixie Gulf Gas Co. of which O. R. Seagraves is president, has issued $9,500,000 10-year first mortgage 6½ per cent sinking fund gold bonds to finance the construction of a natural gas line from near Waskon, Texas, where it connects with the line of the Reserve Natural Gas Co., to the vicinity of Houston and Port Arthur, Texas. The company has contracts to sell gas to the Pure Oil Co. and The Texas Corp. for use in their refineries and to the Houston Gulf Gas Co., a natural gas distributor in Houston.

The bonds were underwritten by Blyth, Witter & Co., Tucker, Anthony & Co.; Moore, Leonard & Lynch; Goddard & Co., Inc., and Hale, Waters & Co., and offered the public at 9½ to yield 6.55 per cent interest.

Each bond will carry a non-detachable warrant entitling the holder to purchase common stock of the company at the rate of ten shares for each $1,000 principal amount of bonds at $15 per share at any time on or before Sept. 1, 1932, and at $20 per share thereafter until Sept. 1, 1937.

Producers and Refiners Operates at Loss

NEW YORK, Sept. 17.—Producers' & Refiners Corp., subsidiary of the Prairie Oil & Gas Co., lost $603,556 after expenses, interest and depreciation but before depletion and other production department charges in the first half of 1927. In the first half of 1926 the company earned $1,398,350 after depreciation but before depletion. Condensed income statement for the first half of 1927 follows:

Gross operating profit	$1,360,544
Expenses	393,805
Net earnings	$966,739
Other income	27,832
Total income	$994,571
Interest	462.022
Depreciation	1,136,105
*Loss	$603,556

*Before depletion, surrendered leases, abandoned wells and extraordinary losses.

Reiter Foster Co. Income Report

NEW YORK, Sept. 17.—Reiter Foster Co. reports earnings of $110,-852 after expenses, interest, charges for dry holes but before depreciation, depletion and federal taxes for the first six months of 1926. Condensed income statement follows:

Gross income	$171,519
Expenses, interest, dry holes, etc.	60,667
Operating income	*$110,852

*Before depreciation, depletion, taxes, etc.

THE OIL INDUSTRY EXCHANGE

Positions Wanted

C. A. Knight recently returned from Argentina where he was employed by the Bethlehem Steel Co., in the capacity of General Superintendent of Refinery, wishes to make connection with some Company as Superintendent or in an Engineering capacity. Address 924 North Lawrence, Wichita, Kansas.

Situations Open

EXPERIENCED SALESMAN with established trade throughout the states of Missouri, Iowa, Nebraska, and Minnesota, to handle refined products as well as absorption gasoline. Excellent position for man who can show results.

Address P. O. Box 1929, Tulsa, Okla.

We have an opening for two more High Grade specialty salesmen to call on the Wholesale Oil Trade. Only men of proven ability and who know the trade will be considered.

The Air Scale Company,
Toledo, Ohio.

REFINER AND GASOLINE MANUFACTURER wishes to employ an experienced, high-class marketer, one who is capable to trade in the buying and selling of absorption gasoline as well as refined products. Liberal salary to party who can show results. Must enjoy an A-1 reputation and good following.

Address P. O. Box, 1929, Tulsa, Okla.

High Grade Equipment Salesman Wanted

A manufacturer of an established and well advertised item of equipment for service stations has an opening for a high grade man well acquainted with major oil companies and capable of earning a minimum drawing account of $6,000 a year.

This is a real opportunity for a man who is really qualified—but a waste of time for the floater or the man seeking big money with little work.

A personal interview will be arranged if your letter or wire indicates you are worth considering.

Address Box 952

Business Opportunities

EDWARD REISER
Broker in
OIL MARKETING PROPERTIES
Second & Walnut St., N.E.
CANTON *Tel. 29405* OHIO

For Sale

WHOLESALE JOBBING BUSINESS FOR SALE, near Philadelphia, Pa. Now doing better than sixty thousand gallons a month. Bulk plant located on tide water. Will sell as whole or interest to man with experience. Address Box 954.

One slightly used 15,000 gallon fuel oil storage tank for sale. 10' 6" x 21' 7" long, equipped with steam coil and carrying underwriter's label. Address P. O. Box No. 486, Elkhart, Indiana.

ONE 7,500 GALLON STEEL RAILROAD TANK FOR SALE, heavy steel suitable for above or underground storage, perfect condition. $175.00 Burr Oak Mill, and Elevator, Burr Oak, Kansas.

1500
DRUM DOLLIES
Especially designed to carry drums or barrels. Provided with two adjustable tie-rod clamps to secure drum on carriage. Dollies are new, and will be sold at an attractive price. If you are interested in buying the entire lot address Box 953.

Miscellaneous

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"For Sale," "Wanted to Buy," "Help Wanted," "Business Opportunities," "Miscellaneous" classifications, set in type this size without border—10 cents a word. Minimum charge, $3.00.

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Unit of Union Carbide and Carbon Corporation
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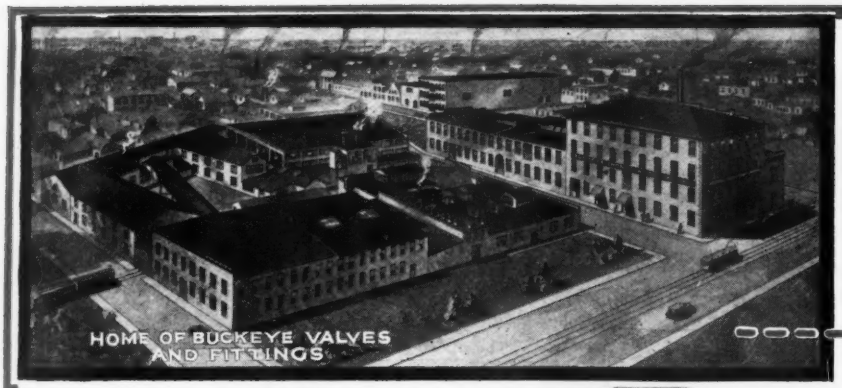
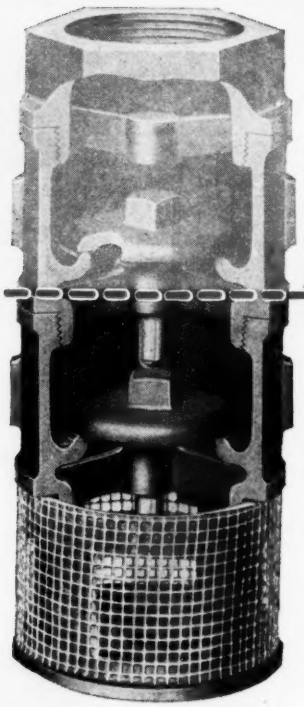
Entered as second class matter January 17, 1910 at Cleveland, O., post office under act of March 3, 1879, by National Petroleum Publishing Co.





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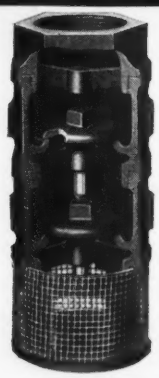
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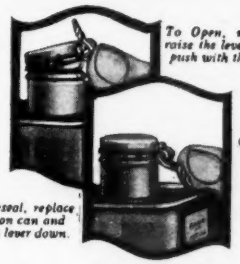

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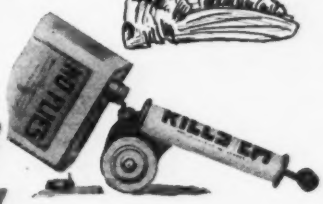

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* The United States Supreme Court defines the word "good-will" as: "the disposition of the pleased customer to return to the place where he has been well treated." Champlin Oils can thus be designated as the "good-will oils", because they bring Champlin users back to Champlin dealers for "more of the same."

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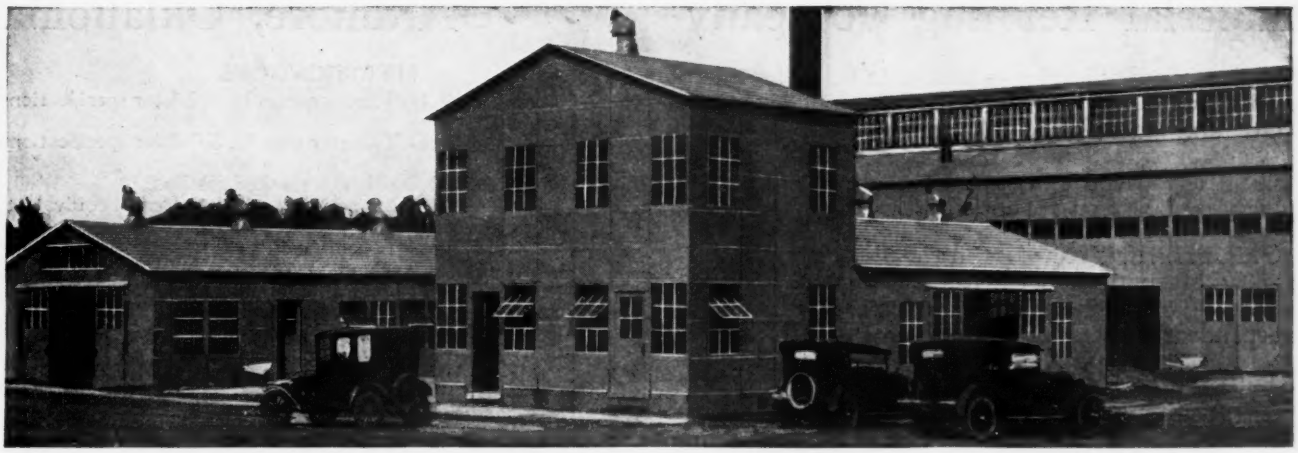
OF COPPER STEEL

Standardized for the Oil Industry



The various types of Truscon Buildings can be planned to meet any condition. The two-story building in the front is used for offices, with a garage building adjoining at the rear.

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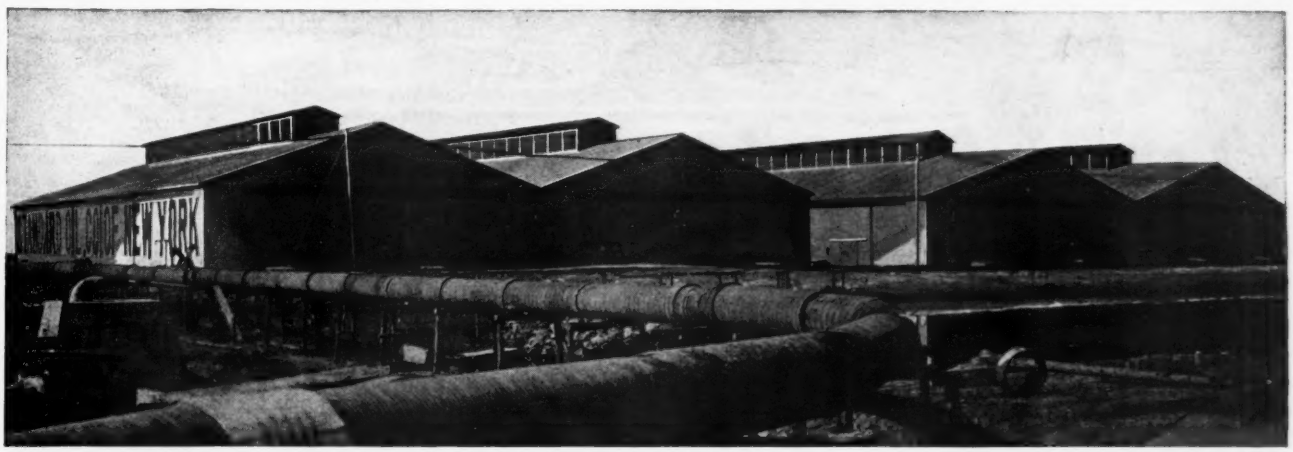
TYPES 1 and 3-M



The various types of Truscon Buildings can be combined as desired to solve any storage problem. Each building in this group has unobstructed floor space with a large central door for convenient trucking.

COMBINATION OF
SERIES: A
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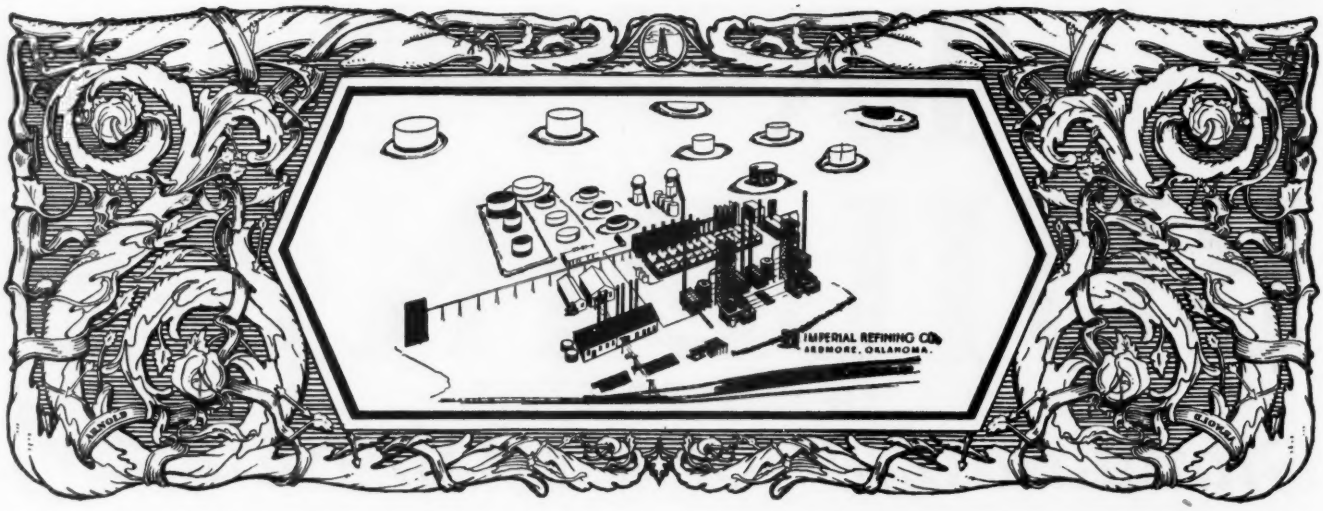
Established 1903

Warehouses and Offices in all Principal Cities.



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We maintain no bulk or retail stations. We are refiners and distributors to the independent jobber.

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Flash 150-175 Cleveland open cup.
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Cold test — below zero. Odor—sweet (acid treated)
28-30 Gravity straw gas oil.
Flash 225-235 Cleveland open cup.
Fire 245-255. Sulphur under 2 per cent.
Cold test—below zero. Odor—sweet.
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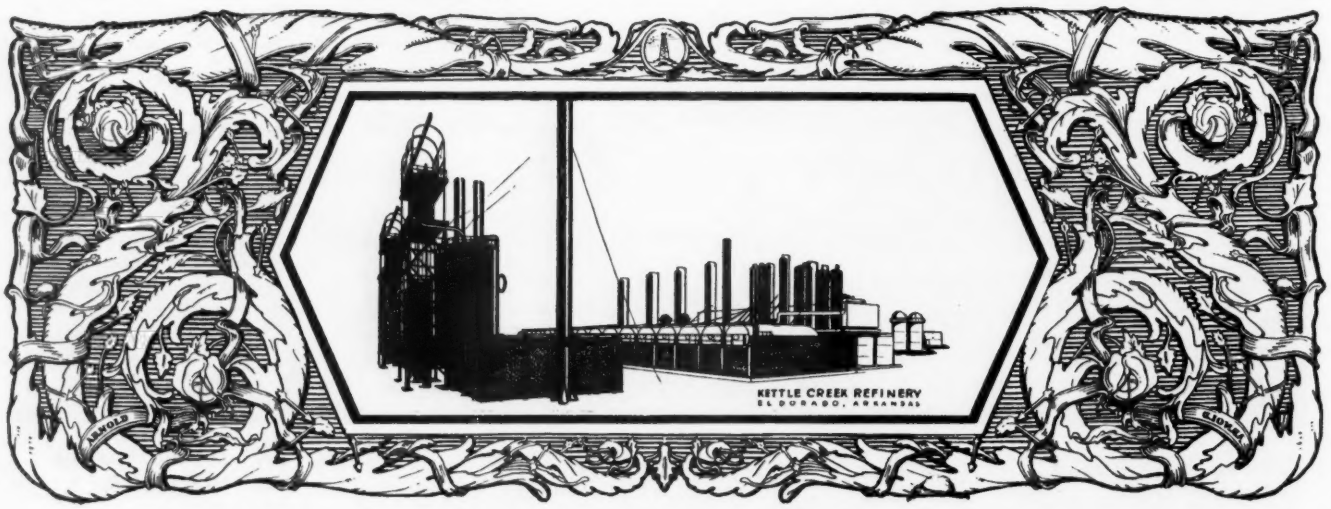
Kettle Creek Refinery - - - - - Eldorado, Arkansas



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ARDMORE, OKLA.

KETTLE CREEK REFINING CO.
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All sales handled through our own sales division

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TULSA, OKLAHOMA

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MILES no longer count. New York gets a "close-up" of Hollywood and Oregon "rides the surf" at Miami. The automobile has brought the Atlantic to the Pacific.

You've seen them speeding along, eating up the miles. License plates of blue and white, orange and black, green and white, red and blue. Bag and baggage on the running boards.

The tourist buys plenty of oil. Burned-out bearings are costly in time and money.

He has become acquainted with the Rhodes Method of oil dispensing. Rhodes Dispensers display your oil so that it can be seen from a distance. They draw the tourist to your station when oil is needed.

Help your big profit maker, oil, make good by displaying it in Rhodes Equipment. Equip your station today and get your share of the oil business of the thousands of tourists who are homeward bound this month.

JAY B. RHODES COMPANY
Kalamazoo, Michigan

RHODES *PRE-FILLED*
OIL DISPENSERS

TWO MODERN REFINERIES

—each equipped to manufacture Gasoline, Kerosene, Distillate and Fuel Oil of the Quality you want....

—And an efficient distributing organization EXCLUSIVELY devoted to the Service of Jobbers.....

Write or Wire

TIDAL REFINING COMPANY

TIDAL BUILDING
Tulsa, Oklahoma

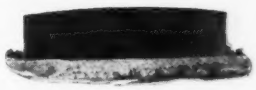
TIDAL

Sunk *in the* Ground

where *corrosion* works unseen

Three coats of pure red-lead most practicable method of protecting buried steel

Buried steel tanks and pipe lines should be carefully painted before being buried. The paint should have time to dry thoroughly.



STEEL buried in the ground is threatened by unusual danger from corrosion. The surrounding earth is nearly always damp. Ground water is a constant menace to the metal.

Under most conditions, the most feasible method of protection is a three-coat covering of pure red-lead. Paint made of red-lead adheres closely to steel. It is moisture-proof. It is not affected by the chemical substances that are ordinarily found in ground water. It offers durable, economical protection.

Where the soil condition is strongly alkaline, of course no paint is suitable. In such a case, the oil vehicle of the paint will be turned to soap.

Tanks sunk in the ground are sometimes protected as follows: Three coats of red-lead are applied. The tank is then buried in sand, which acts as a filter. In damp soil, a metal tank so treated will last for many years without further attention. In dry soil it will last even longer.

Red-Lead favored

A questionnaire showed that oil men in every oil field in the United States favored red-lead for metal protection. Fifty-three oil men answered. Thirty-two (or 3 out of 5) are red-lead users.

Dutch Boy red-lead was preferred by many of these oil men. You can get it in either paste or liquid form. The liquid comes in the orange-red for next-to-metal coats and in greens, browns and black for finishing coats. The paste comes in the orange-red and can be shaded to dark colors.

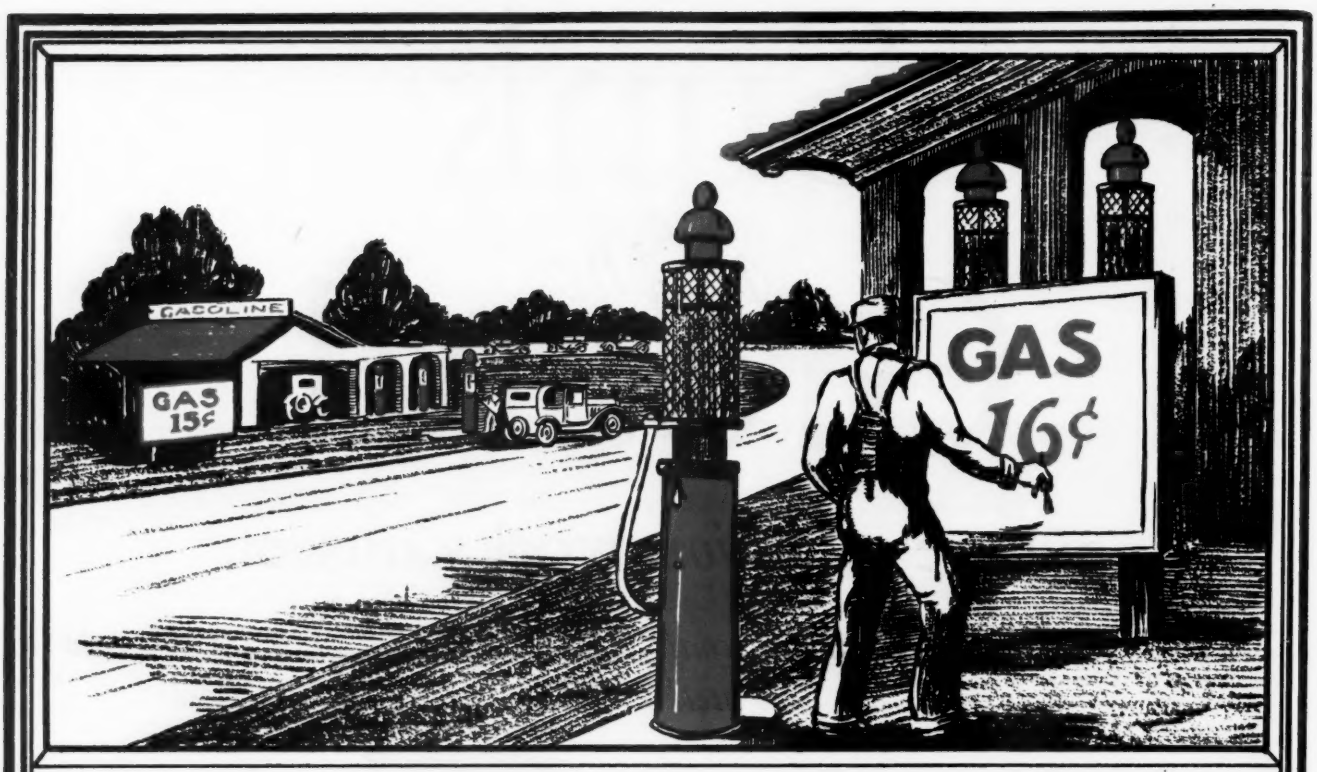
Tanks and tank cars painted in light colors guarantee a large yearly saving in oil. Dutch Boy white-lead is ideal for reducing evaporation losses in this manner. And used over an undercoating of Dutch Boy red-lead it not only cuts your evaporation losses to a minimum, but gives the same weather protection.

We shall be pleased to help you solve any question of metal protection. Specialists on our technical staff have made a study of paint for the oil industry. Their assistance is free of charge. Address our nearest branch.

NATIONAL LEAD COMPANY

New York, 111 Broadway — Boston, 800 Albany St.
Buffalo, 116 Oak St. — Chicago, 900 West 18th St.
Cincinnati, 659 Freeman Ave. — Cleveland, 820 W. Superior Ave.
St. Louis, 722 Chestnut St. — San Francisco, 485 California St.
Pittsburgh, National Lead & Oil Co. of Pa., 316 Fourth Ave.
Philadelphia, John T. Lewis & Bros. Co., 437 Chestnut St.

DUTCH BOY RED-LEAD



How Can Retail Prices Be Stabilized?

NO sound business plans can be laid by the independent dealer if retail prices cannot be stabilized.

This obstacle is now being felt in many parts of the country today and no territory is exempt from the danger of the price cutter.

There is one great stabilizing factor which will do much to keep the independent dealer's business on an even keel, thru the hectic price wars. That is the handling of nationally known and *accepted* petroleum products.

An established volume of business on such products means a bulwark of protection against the price cutter.

Such a product is HyVis Motor Oil—the nationally advertised Pure Pennsylvania brand distributed exclusively thru independent dealers and distributors. Altho HyVis is established from coast to coast, some very attractive territories are still open. Perhaps one of them is yours.

The FRED G CLARK Co

Main Office: Cleveland, Ohio — ***Refineries:* Warren, Pa.**

Branch Offices and Plants at: **Chicago** **Minneapolis** **Warren, Pa.** **Lincoln, Neb.**